

29

*S. S. Ghosh*

SOCIETY OF  
BIOLOGICAL CHEMISTS, INDIA.

ANNUAL REVIEW  
OF  
BIOCHEMICAL AND ALLIED  
RESEARCH IN INDIA  
VOL. IX, 1938.

MAY 1939

BANGALORE, INDIA.

PRICE Rs. 3 OR 6 SH.







1  
M Gururaja Doss  
Gururaja Doss  
KS  
Doss Doss

u  
Gururaja Doss  
Gururaja Doss  
K.S.

u  
Gururaja Doss  
Gururaja Doss  
KS.

Gururajadoss  
Gururaja Doss  
Doss: Gururaja Doss  
KS.

G Gururaja Doss  
Gururaja Doss  
Gururaja Doss

Gururaja Doss  
G Gururajadoss  
Gururaja Doss

11  
G Gururajadoss  
Gururajadoss  
Gururajadoss







# Society of Biological Chemists, India. *Chemists*

## ~~Aims and~~ Objects. AIMS AND OBJECTS.

The Aims and Objects of the Society are to :

*M. L. Rao*

1. Co-ordinate the work of Biological Chemists in various parts of India.
2. Hold meetings either under the exclusive auspices of the Society or in association with other societies, for discussion of important topics of scientific interest and for presentation of original papers.
3. Publish annual reviews, abstracts of the biochemical work done in India and monographs on special aspects of Biological Chemistry.
4. Conduct a Journal when deemed suitable.

### Membership Fees :

For Individuals, Rs. 3 inland and 6 sh. foreign.

For Libraries, Institutions, Firms and other corporate bodies, Rs. 5 inland and 10 sh. foreign.

Subscriptions are payable in advance and fall due on 1st January each year.

Members and Subscribers are entitled to receive free all current publications of the Society.

### PUBLICATIONS.

#### Price

- |  | Inland | Foreign |
|--|--------|---------|
| 1. "Annual Review of Biochemical Allied Research in India" |        |         |
| for 1930-1936, per volume ...                              | Rs 2   | 4 sh.   |
| Do. for 1937 & 1938 per volume ...                         | Rs. 3  | 6 sh.   |
| 2. "Proceedings" of the Society, Vol. I, 1936 ...          | Re. 1  | 2 sh.   |
| Do. Vol. II, 1937  |        |         |
| (Parts I and II) ...                                       | Rs. 2  | 4 sh.   |
| Do. Vol. III, 1938   |        |         |
| (Parts I, II & III) ...                                    | Rs. 3  | 6 sh.   |
| 3. "Some Aspects of Plant Nutrition,"                      |        |         |
| by Rao Bahadur B. Viswa Nath ...                           | Re. 1  | 2 sh.   |
| 4. "Industrial Possibilities of Some Research Work         |        |         |
| done in India," by Dr. Gilbert J. Fowler ...               | Re. 1  | 2 sh.   |
| 5. "Influence of Light on Some Biochemical                 |        |         |
| Processes," by Dr. N. R. Dhar ...                          | Re. 1  | 2 sh.   |

All communications should be addressed to :

The Hon. Secretaries,

Society of Biological Chemists, India,

Hebbal P. O., Bangalore.



# Proceedings of the Society of Biological Chemists, India.

Contains summaries of papers read and of lectures and scientific discussions held under the auspices of the Society and its different Branch Centres.

Members of the Society are also invited to contribute short accounts (not exceeding 1,000 words) of researches carried on by themselves or under their guidance, **which have not been published elsewhere.**

*All communications to be addressed to :*

The Hon. Secretaries,  
**Society of Biological Chemists, India,**  
Hebbal P. O., BANGALORE.

---

## AVAILABLE FOR SALE

**Biochemical Journal :** Vol. 29 (1935); Vol. 30 (1936); Vol. 31 (1937) and Vol. 32 (1938).—Complete with index and bound in calico.

**Chemical Abstracts** (American): Vol. 28 (1934); Vol. 29 (1935) and Vol. 30 (1936).—Complete with index.

**Industrial & Engineering Chemistry**—Analytical Edition. Vol. 9 (1937) and Vol. 10 (1938).

**Proceedings of the Indian Academy of Sciences.**—Series A and B. Vols. 2, 3, 4, 5, 6, 7 and 8.—Complete with index and bound in calico.

*For further particulars, please write to :—*

A. C/O SECRETARIES,

**SOCIETY OF BIOLOGICAL CHEMISTS, INDIA,**  
HEBBAL P. O., BANGALORE.



*Annual Review of*  
*Biochemical and allied*  
**ANNUAL REVIEW**  
*Research in India*  
**BIOCHEMICAL AND ALLIED**  
**RESEARCH IN INDIA** *1938* —  
**VOL. IX, 1938.**

**CONTENTS**

	PAGE
1. PHARMACOLOGY By B. B. Dikshit ... ..	1
2. ENZYMES By K. V. Giri ... ..	6
3. HUMAN PATHOLOGY AND BACTERIOLOGY By S. M. Banerji ... ..	19
4. FOODS AND NUTRITION By S. Ranganathan and A. R. Sundararajan ...	40
5. PROTEINS By K. P. Basu ... ..	54
6. MICROBIOLOGY AND FERMENTATION By S. V. Desai ... ..	58
7. PLANT PHYSIOLOGY By B. N. Singh ... ..	63
8. SOILS, FERTILIZERS AND MANURES By C. N. Acharya ... ..	81
9. CHEMISTRY OF PLANT PRODUCTS By S. Dutt ... ..	99
10. PHYTOPATHOLOGY-MYCOLOGY By B. B. Mundkur ... ..	110
11. PHYTOPATHOLOGY-ENTOMOLOGY By K. B. Lal ... ..	124
12. ANIMAL NUTRITION AND DAIRYING By A. V. Iyer ... ..	140
13. HUMAN PHYSIOLOGY By N. M. Basu ... ..	145



# SOCIETY OF BIOLOGICAL CHEMISTS, INDIA.

---

## EXECUTIVE COMMITTEE.

### President :

RAI BAHADUR SIR UPENDRANATH BRAHMACHARI,  
KT., M.A., M.D., PH.D., F.A.S.B.

### Vice Presidents :

DR. G. J. FOWLER, D.Sc., F.I.C.  
RAO BAHADUR B. VISWANATH, F.I.C.  
LT-COL. S. L. BHATIA, M.A., M.D., I.M.S.  
MR. R. C. SRIVASTAVA, B.Sc., O.B.E.

### Members.

DR. B. C. GUHA, M.Sc., Ph.D., D.Sc., (Calcutta)  
DR. V. N. PATWARDHAN, M.Sc., Ph. D., A.I.C. (Bombay)  
DR. M. DAMODARAN, D.Sc., F.I.C. (Madras)  
DR. B. K. NARAYANA RAO, M.B.B.S., M.R.C.S., D.O., D.P.H.  
(Bangalore)  
MR. N. V. JOSHI, M.Sc. (Delhi)  
MR. Y. D. WAD, M.A., M.Sc., A.I.I.Sc., (Indore)  
DR. S. KASINATHA IYER, B.A., Ph.D. (Coimbatore)  
DR. T. N. SETH, D.Sc., (Patna)  
RAI SAHIB JAI CHAND LUTHRA, B.Sc., M.Sc., D.I.C. (Lyallpur)  
DR. H. D. SEN, M.Sc., Ph.D. (Cawnpore)  
DR. K.P. BASU, Ph.D., D.Sc. (Dacca)  
DR. J. A. DAJI, M.A., Ph.D. (Poona)  
DR. H. K. SEN, D.Sc., D.I.C. (Ranchi)  
DR. B. SANJIVA RAO, M.A., Ph.D. (Bangalore)

### Hon. Treasurer :

MR. B. N. BANERJEE M.Sc.

### Hon. Secretaries :

DR. C. N. ACHARYA M.Sc., Ph.D., A.I.C.  
MR. B. H. IYER, M.Sc., A.I.I.Sc.



# I. PHARMACOLOGY

*By B. B. Dikshit*

Experimental investigations in the field of Pharmacology were continued in various laboratories in India, the majority of the contributions being made by workers in the school of Tropical Medicine, Calcutta, and in the Biochemical Standardization Laboratory of Calcutta.

Miss Bhagvat<sup>1</sup> has described an enzymic method for the estimation of adrenaline colorimetrically. The enzyme was prepared from the seeds of *Dolichos lablab* and it was shown that it oxidised adrenaline to a red-colour compound. The colour formation took place between pH 4.4 and pH 7.6 and the colour was found to be more stable in the acid range. The sensitivity of the method was upto 1 in 500,000 and a good proportionality existed between different concentrations of adrenaline. Miss Bhagvat compared this method with chemical and biological methods and found a good agreement between the enzyme and biological methods while the chemical methods gave variable results.

Nandi and Dikshit<sup>2</sup> have described a new colorimetric test for the estimation of plasmoquine. The test can detect plasmoquine up to a dilution of 1 in 1 million and a quantitative determination can be made up to a dilution of 1 in 200,000. The test consists in adding a few drops of Folin's phenol reagent to an aqueous acid solution of plasmoquine and the mixture is made strongly alkaline by the addition of  $\text{Na}_2\text{CO}_3$  when a blue colour develops in a few minutes and reaches its maximum intensity in about half an hour. The colour remains constant for about 3 hours, after which it gradually fades. The test can be applied to determine plasmoquine in tissues but cannot be extended to detect or estimate plasmoquine in the urine.

---

1 Bhagvat, K. (1938), *Ind. Jour. Med. Res.*, **25**, 911.

2 Nandi, B. K. and Dikshit, B. B. (1938), *Ibid.*, **25**, 937.



Interesting investigations on some biochemical properties of cobra and Russell's Viper venom were conducted by Roy and Chopra<sup>3</sup>. They found that viper venom contains more albumin and less pseudoglobulin than cobra venom; while the viper venom contains about 3% euglobulin, no euglobulin could be detected in the cobra venom. Invertase and diastatic enzymes were absent in both and these venoms could digest fibrin and casein, could liquify gelatine and clot milk. Cobra venom was found to possess haemolytic property but the viper venom was poor in it.

Roy<sup>4</sup> continued these investigations and compared the lipolytic properties of these two venoms. Both of them were found to act on lecithin, the viper venom being the stronger of the two. The lecithinase was found to stand boiling for 15 to 20 minutes, but was inactivated on autoclaving. Esterase activity of these venoms was also studied by Roy and it was found that cobra venom possessed a high esterase activity but the viper venom did not.

The question of the site of action of cardiac glucosides and other drugs which stimulate the heart, has always been one of considerable pharmacological interest and Chopra, Das and Mukerji<sup>5</sup> have given a new lead in the line of investigation of the action of such drugs by developing a method of heart explants from chick embryos. They cultivated explants from chick embryos 2 to 7 days old *in vitro* and as no nerves develop at this stage they succeeded in getting a completely aneural preparation to try the effect of various drugs. They tested lanadigin, thevetin, strophanthin, caffeine and cardiozol and found that all these possessed a direct action on the cardiac muscle. Caffeine was found to possess an additional property of causing the heart explants to continue pulsation for a longer period than the controls.

Chopra, Mukerji and Chakravarty<sup>6</sup> have investigated the haemolytic activity of about 14 different hydrocupreidine derivatives and have drawn some important conclusions on the relation between the

---

3 Roy, A. C. and Chopra, R. N. (1938), *Ind. Jour. Med. Res.* **26**, 241.

4 Roy, A. C. (1938), *Ibid.*, **26**, 249.

5 Chopra R. N., Das, N. N. and Mukerji, B. (1938), *Ibid.*, **26**, 271.

6 Chopra R.N. Mukerji, B. and Chakravarty M, (1938), *Ibid.*, **26**, 279.



chemical constitution of these drugs and their haemolytic action. They find that the haemolytic activity increases with the increase in the number of carbon atoms in the side chain. The isocompounds were practically equal in potency to normal derivatives. They further observed that hydrocupreidine derivatives had a similar haemolytic activity and this was lowered in presence of serum.

Mukerji and Iyengar<sup>7</sup> extended this investigation to digestive enzymes and found that the laevo-rotatory hydrocupreins had a more powerful inhibitory action on the amylases than the dextro-rotatory hydrocupreidines. The lower members of the hydrocupreidine series did not possess any inhibitory action on the invertase activity but the higher ones did. It is suggested that the alkyl radicals ( $\text{CH}_2$  groups) react with the active enzyme of the amylases and produce inhibition of the enzyme.

Mukerji and Guha<sup>8</sup> studied the effect of anterior pituitary extracts and choline on the liver fat of rabbits. They observe that a single injection of a large dose of anterior pituitary extract can produce a fatty infiltration of the liver within 24 hours. Choline chloride fed in doses of 0.5 gm. per Kg. of body weight of the animal failed to prevent the increase in liver fat. This treatment with choline, however, brought about a change in the iodine number of the fatty acids.

In a preliminary note on the chemistry and pharmacology of the leaves of *Skimmia laureola* Hook F., Chopra, Chatterjee, De and Ghosh<sup>9</sup> observe that the alkaloid isolated from this plant was identical with that isolated by various workers from the Japanese variety *Skimma japonica* Thunb. The alkaloid being soluble only in excess of acid, attempts to elucidate its pharmacological action were not very successful.

Chopra, Ghosh and Dutt<sup>10</sup> have continued their investigations on "Some inorganic preparations of the Indian indigenous medicines" and have reported their observations on '*Samudra phena*'. They

7 Mukerji, B. and Iyengar, N. K., (1938), *Ind. Jour. Med. Res.* **26**, 289.

8 Mukerji, B. and Guha, R. C., (1938), *Ibid.*, **26**, 295.

9 Chopra, R. N. Chatterjee, R. G., De, N. and Ghosh, S., (1938), *Ibid.*, **26**, 481.

10 Chopra, R. N. Ghosh, S. and Dutt, A. T. (1938), *Ibid.*, **26**, 485.



analysed a sample and found it to contain lime, silica, iron, alumina, and sodium chloride in quantities which could be estimated and traces of potash, magnesia and sulphates. Lime formed nearly 50% of the bulk and Ca was evidently the chief therapeutic agent. The authors conclude that an impure and uncertain product like this does not offer any special advantage over pure salts of calcium, which are now available for use in medicine.

De and Basu<sup>11</sup> investigated the chemotherapeutic activity of certain compounds related to the sulphonamides and found that replacement of the amide hydrogen of p-amino-benzene-sulphonamide by 8-quinolyl, 6-methoxy-8-quinolyl, or 8-diethyl-amino-butyl groups, increased the toxicity without increasing the bacteriostatic activity of the sulphonamide.

In a very interesting note on the action of 'soluseptasine' in Simian malaria, Chopra and Das Gupta<sup>12</sup> record that two injections of 2 c.c. of the drug, one given intravenously and the other intramuscularly 24 hours later, completely cured a monkey suffering from a heavy infection of *Plasmodium knowlesi*. The same authors<sup>13</sup> tried the action of prontosil-soluble in Simian malaria and concluded that although the drug in large doses checked the infection, it had no advantages over other commonly used antimalarial drugs.

Narayana<sup>14</sup> studied the antagonism between ergotamine and adrenaline on the vessels of the hind limbs of frogs and found no evidence to show that ergotamine abolished or reversed the action of adrenaline.

The influence of adrenaline and acetylcholine on the effects of Ca and K ions was studied by Basu and Mukherjee<sup>15</sup> on the skeletal muscles of frogs. They found that addition of Ca and adrenaline makes the contractions more powerful and causes an early onset of fatigue. When the Ca concentration was increased,

---

11 De., S. P., and Basu, V. P. (1938), *Ind. Jour. Med. Res.* **26**, 537.

12 Chopra, R. N. and Das—Gupta, B. M. (1938), *Ind. Med. Gaz.* **73**, 395.

13 Das—Gupta, B. M. and Chopra, R. N. (1938), *Ibid.*, **73**, 665.

14 Narayana, B. (1938), *Pro. 25th Ind. Sci. Congress Part III*, 985.

15 Basu, N. M. and Mukherjee, G. C. (1938), *Ibid.*, 285.



however, the fatigue was delayed. High concentrations of K reduced contraction as well as relaxation and quickened fatigue, while acetylcholine delayed this onset of fatigue.

Basu, Mahalanobis, Mitra and Banerjee<sup>16</sup> extended this investigation to the perfused frog's heart. They found that in the absence of Ca, acetylcholine is quite effective but with increasing concentrations of Ca, the acetylcholine action proportionately diminishes. They also found that the presence of K was necessary for a ready response of the frog's heart to acetylcholine. The authors further observed that vagus stimulation is effective in absence of Ca, but the presence of subnormal quantities of Ca in the perfusate rendered such stimulation ineffective.

Basu and Mukherjee<sup>17</sup> studied the effects of adrenaline, histamine, phloridizin and cobra venom on blood vessels by perfusing the vessels of frogs. They found that adrenaline and phloridizin constricted the vessels while histamine dilated them. Cobra venom had no action on the perfused blood vessels.

---

<sup>16</sup> Basu, N. M. Mahalanobis, S. K. Mitra, M. C. and Banerjee, G. G. (1938), *Proc. 25th Ind. Sci. Congress, Part III*, 286.

<sup>17</sup> Basu, N. M. and Mukherjee, G. C. (1938), *Ibid*, 286.



## II. ENZYMES.

*By K. V. Giri.*

The activity in the field of enzymes continues to increase steadily year by year. Important contributions to the basic problem of enzymic proteolysis have been made by Damodaran and co-workers from the University Biochemical Laboratory, Madras. Studies on the relation between enzymic function and therapeutic and pharmacological properties of snake venom and other drugs are being actively pursued by Colonel Chopra and co-workers in the Biochemical Standardisation Laboratory of the All India Institute of Hygiene and Public Health and the Department of Pharmacology, School of Tropical Medicine, Calcutta. From the Haffkine Institute Laboratories, Bombay, studies on choline esterase are being continued under the able guidance of Col. Sokhey. Several useful publications have appeared from the Department of Biochemistry, Indian Institute of Science, Bangalore on (a) the activation of enzymes, (b) the relation between enzymes and vitamins and (c) the behaviour and properties of amylases and phosphatases. It is gratifying to note that during the period under review, a few Indian scholars working in the Biochemical Laboratories, Cambridge and the Biochemical Institute of the University of Stockholm have made important contributions to our knowledge of the action of dehydrogenases and phosphorylating and dephosphorylating enzymes in muscle.

### **Carbohydases.**

A very considerable and rapidly increasing amount of attention is now being given to the study of the amylases in their relation to starch. From the study of the hydrolysis starch by sweet potato amylase, Giri<sup>1</sup> has thrown fresh light on the constitution of starch and the nature of the amylase. The present findings of the

---

<sup>1</sup> Giri, K. V. (1938), *Ind. Chem. Soc.*, **15**, 249.



author have reinforced the view previously developed by him that the enzyme behaves like a pure  $\beta$ -amylase. Thus, the saccharification limit for the hydrolysis of starch by sweet potato amylase corresponds to the value obtained with  $\beta$ -amylase of barley, and the nature of the hydrolysis of amyloamylose is characteristic of pure  $\beta$ -amylase. The enzyme selectively hydrolyses a portion of the starch substance, leaving a residual material which resembles erythrogranulose. Amyloamylose is hydrolysed completely without noteworthy inhibition by sweet potato amylase and barley  $\beta$ -amylase, and the colour with iodine remains unchanged until complete saccharification takes place. It is suggested that  $\beta$ -starch possesses groups which produce colour with iodine.

The mechanism of the changes in the amylase activity of rice grain during ripening and germination has been further examined by Giri and Sreenivasan<sup>2</sup>. The authors find that the amylase and phosphatase activities of the aqueous extracts of the grain and the inorganic phosphorus content increase during germination, while the reverse process takes place during the ripening of the rice grain. It is found that the aqueous extracts of bran contain a higher concentration of the amylase than that of endosperm. The authors have discussed the role played by phosphate in regulating the amylase activity, during ripening and germination of rice grains.

Jain and Agarwal<sup>3</sup> have isolated the amylase from the fruits of Indian water chestnut (*Trapa bispinosa Roxb*) in a pure powder form and studied the course of its action on starch. It is found that the velocity constants calculated on the basis of a monomolecular reaction give a constant value only after the reaction has proceeded for about 90 minutes. The maximum velocity is found to be at 0.25 per cent starch concentration. The optimum pH and the optimum temperature for the activity of the enzyme are 5.2 to 5.6 pH and 45 to 50° C. respectively.

### Proteolytic Enzymes.

From the University Biochemical Laboratory, Madras, important papers have appeared during the period under review, which

2 Giri, K. V., and Sreenivasan, A. (1938), *Biochem. Z.* **296**, 429.

3 Jain, D. N. and Agarwal, R. R. (1938), *Proc. Ind. Acad. Sci.*, **7A**, 384,



have thrown considerable light on the basic problems of enzymic proteolysis. Damodaran and Anantanarayanan<sup>4</sup> have made a systematic study of the formation of ammonia and the hydrolyses of peptide linkages during the action of pepsin, trypsin, erepsin and papain on three typical proteins, viz., casein, edestin and gliadin. It is found that amide and peptide hydrolysis do not run parallel and that the ammonia formed is due only to a small extent to proteolytic action, and is formed mainly from the decomposition of the primary products of protein hydrolysis. This secondary decomposition is not due to enzyme action, but is the result of the acidic or alkaline reaction of the digestion mixture. In papain digestion, however, it is found that ammonia formation is connected with enzyme action. Papainase, therefore, possesses either deamidase activity or contains a component which exhibits such activity. Whether this function of hydrolysing both the peptide and amide bonds resides in the same enzyme, or whether papain contains two components with these two specific functions, is a problem for further study.

In a subsequent communication, Damodaran and Narayanan<sup>5</sup> have reported the results of their investigations on the action of pepsin, trypsin, erepsin and papain on asparagine, glycineamide, *dl*-leucinamide, glycyl-l-asparagine, *d*- and *l*-leucyl-asparagine, chloroacetyl-l-asparagine and anhydro-glycylasparagine (2:5-diketopiperazine acetamide). The authors find that the amide group in leucinamide, asparagine and glycineamide is hydrolysed by trypsin-free erepsin, the rate of hydrolysis decreasing with the three substrates in the order given. Trypsin-free erepsin is also found to hydrolyse the peptide group in chloroacetyl asparagine, but the amide group in the asparagine peptides investigated is not attacked by the enzyme. Pepsin, erepsin-free trypsin and papain are found to have no action upon the amide or peptide groups in glycineamide, leucinamide, asparagine, glycylasparagine or leucylasparagine.

---

4 Damodaran, M. and Anantanarayanan, P. (1938), *Biochem. J.*, **32**, 1877.

5 Damodaran, M. and Narayanan, E. K. (1938), *Ibid.*, **32**, 2105.

6 Damodaran, M. and Krishnan, P. S. (1938), *Ibid.*, **32**, 1919.



Anhydroglycylasparagine (2:5-diketopiperazine acetamide, is not hydrolysed either at the peptide or the amide bond by any of the enzymes investigated. In the light of their findings, the authors have briefly discussed the specificity of the proteolytic enzymes and the "amide" nitrogen of proteins.

There has been considerable difference of opinion as to the formation of free amino-acids, particularly tyrosine, during the digestion of proteins by pepsin. The view generally held has been that pepsin splits proteins into higher peptides, from which amino-acids are liberated only by the further action of other specific enzymes called peptidases. Recently, Damodaran and Krishnan have obtained clear evidence to show that tyrosine is liberated during peptic digestion of casein. The authors have shown that after seven days' digestion of casein, about 6% of the tyrosine and about the same proportion of the total nitrogen of the protein are in a form not precipitable by phosphotungstic acid. Tyrosine has been isolated from peptic digests of casein, carried out under conditions where bacterial contamination was completely excluded. The yield of tyrosine thus isolated amounted to about 1.7—1.8% of the total tyrosine in the protein.

Ganapathy<sup>7</sup> and Sastri have shown that papaya latex is rich in SH compounds (about 2%) and that about a tenth of it is glutathione. In a subsequent note to *Nature*<sup>8</sup> the authors have reported that treatment of an ether extract of fresh papaya latex with  $H_2O_2$  (to oxidise all SH to S—S) and subsequent precipitation with alcohol gives a precipitate which is inactive towards peptone but retains its capacity to hydrolyse gelatin. Maleic acid, which has been recently shown to inhibit the activity of enzymes whose action depends on the presence of SH groups, is found to have no effect on the gelatinase activity of the preparation. Iodoacetic acid, however, inhibits it irreversibly. Hence, the authors suggest that the SH group is not necessary for the gelatinase activity of papain, but is essential for the peptonase activity. It

---

7 Ganapathy, C. V. and Sastri, B. N. (1938), *Current Science*, **6**, 830.

8 Ganapathy, C. V. and Sastri, B. N. (1938), *Nature*, **142**, 539,

9 Okomura, S. (1938), *Bull. Chem. Soc., Japan*, **13**, 534.



would be of interest to mention here that Okomura<sup>9</sup>, a Japanese worker, has obtained a preparation which gives a negative SH reaction with or without HCN, but hydrolyses gelatin more rapidly with HCN than without. Thus, it is clear that for gelatinase activity SH groups are not essential. In another communication, Ganapathy and Sastri<sup>10</sup>—have reported the results of their investigations of the natural activators of papain. The authors have shown that glutathione is a natural constituent of all plant juices which are reputed sources of proteinases. Thus, the pressed juice of pine apple, *Ficus bengalensis*, cucumber and *Calatropis gigantea* contain glutathione. The natural activator of papainase is, therefore, found to be identical with that of liver cathepsin or yeast proteinase. It would be of interest to know whether glutathione is the only natural activator of papain, or whether other constituents are present in plant tissues which may have a similar action on the proteinase.

### Esterases.

Choline esterase is an enzyme which plays an important role in mammalian physiology and pathology. Acetylcholine is a physiologically important substance, which has a powerful effect upon the blood pressure and upon muscle contraction. The choline esterase content of blood, therefore, may be of diagnostic value in heart studies. Mahal<sup>11</sup> has recently investigated the choline esterase activity of blood under different physiological conditions. It is found that the choline esterase activity of blood or serum varies in different animal species and among individuals of the same species, but it remains constant for each individual over long periods. The enzyme activity of serum obtained from arterial blood is found to be the same as that of the serum obtained from the venous blood; and blood taken from the animal some minutes (40 min.) after death is found to retain its activity. The activity is unaffected when the serum is stored in the refrigerator, but is reduced by dilution with

---

10 Ganapathy, C. V. and Sastri, B. N. (1938), *Proc. Ind. Acad. Sci.*, **3 B**, 399.

11 Mahal, H. S., (1938), *Indian Jour. Med. Res.*, **25**, 703.



water. Sleeplessness, changes in environmental temperature, fasting or glucose feeding, and subcutaneous injection of various drugs like strychnine sulphate, morphine hydrochloride, acetylcholine bromide, and cobra venom are found to have no effect on the choline esterase content of blood.

Iyengar and co-workers<sup>12</sup> have shown that cobra venom (0.005 per cent) hydrolyses acetylcholine but not ethyl butyrate, and that esterine inhibits the reaction. Russell's viper venom is found to have no choline esterase activity. The authors suggest that the presence of choline esterase in the venom probably explains its effect in paralysing the respiratory muscles, but not necessarily its central effect.

Investigations on plant phosphatases have been continued by Giri<sup>13, 14</sup> who has recently published in detail the results of his investigations on the relation between vitamin C and phosphatases, a preliminary account of which had already appeared in the Annual Review for 1937.

The magnesium activation of tissue phosphatases has been systematically studied by Giri<sup>15</sup>, who discusses the practical significance of the results in their bearing on the determination of the phosphatase activity of tissues. The usual method adopted for the determination of the activity of tissue phosphatases consists in the extraction of the fresh tissue with water and determining its action on phosphoric esters in presence of an optimal concentration of magnesium. Giri has shown that the phosphatase activity of the aqueous extracts of tissues is influenced by (a) the method of extraction, (b) the age of the preparation, and (c) the presence or absence of inhibitors and substances which interfere with magnesium activation. It is pointed out that in the determination of the quantitative distribution of phosphatases in tissues, consideration should be given to the above factors. It is shown that the activity of tissue phosphatases (kidney and liver) in presence of magnesium is greater after ultrafiltration than that of the crude extracts. The impurities in

---

12 Iyengar, N. K. and Sehra, K. B. (1938), *Current Science*, **7**, 51.

13 Giri, K. V. (1938), *Nature*, **141**, 119.

14 Giri, K. V. (1938), *Zeit. physiol. Chem.*, **254**, 126.

15 Giri, K. V. (1938), *Ibid.*, **254**, 117.



the extracts of tissues, particularly those which are prepared by long autolysis of the tissue material, are found to greatly influence the activity of the phosphatases. The author, therefore, suggests that ultrafiltration of the extracts may be usefully employed for eliminating the adverse effects of impurities on phosphatase activity determinations. The bearing of these results on the changes in the phosphatase activity of pathologically altered tissues and blood is discussed in detail by the author.

From the Biochemical Laboratory, Cambridge, Pillai,<sup>16</sup> has reported the results of his investigations on the dephosphorylating action of muscle extract on various substrates. Among the three phosphatases present in fresh muscle extract—hexosediphosphatase, inorganic pyrophosphatase and adenylypyrophosphatase—the last is found to be least stable. Attempts to separate the two pyrophosphatases by adsorption were not very successful, but the author has adduced evidence to show that the two are distinct and separate enzymes. Thus he has obtained an acetone powder extract of muscle, which is found to be free from adenyly pyrophosphatase, while the other two phosphatases are present in active form. This extract does not dephosphorylate adenylypyrophosphate but it dephosphorylates phosphoglycerate in the presence of magnesium and adenylypyrophosphate. Creatine phosphate is found to be unaffected under these conditions. Flouride but not iodoacetate inhibits the dephosphorylation. The dephosphorylation of phosphoglycerate is found to be activated by arsenate; and adenylypyrophosphate, magnesium and cozymase are found to be necessary for this activation. Flouride and iodoacetate inhibit the dephosphorylation. The author has not obtained any experimental evidence to show that the mechanism of the reaction by which adenylypyrophosphate could serve as phosphate acceptor is due to (1) the presence of traces of hexosemonophosphate formed by dephosphorylation of hexosephosphate by the phosphatase present or (2) the presence of reduced cozymase acting as phosphate carrier,

---

<sup>16</sup> Pillai, R. K., (1938), *Biochem. J.*, **32**, 1087.



Giri<sup>17</sup> has studied the distribution of phytase in plants. It is found that the phytase activities of tubers, vegetables and leaves are very high compared to those of cereals. The importance of this enzyme in phytin nutrition is discussed.

## Oxidising Enzymes.

### (a) *Dehydrogenases or Anaerobic oxidases.*

From the Biochemical Institute, Stockholm, Das in collaboration with Hans Von Euler and others, has published important papers on biological dehydrogenation and synthesis of glutamic acid in plant and animal tissues. Das<sup>18</sup> *et al* have shown that glutamic acid apodehydrogenase from higher plants and animals differs from that obtained from yeast in that it has coenzyme specificity and combines only with codehydrogenase I giving holodehydrogenase. Plant apodehydrogenases are found to act only on 1-glutamic acid. Ketoglutaric acid inhibits the action just as for yeast dehydrogenase. Dialysis of the enzyme solution is found to remove the activator, which is thermostable, stable to acid, and unstable to alkali. It is not precipitated by mercuric acetate, barium hydroxide, picric or picrolinic acid. The activator is quantitatively adsorbed by alumina and can be eluted with sodium phosphate. It is not fermented by yeast. It is found that liver, brain and heart also contain glutamic acid apodehydrogenase, which acts only on 1-glutamic acid. The authors have discussed the mechanism of glutamic acid dehydrogenation and synthesis.

In another communication<sup>19</sup> the authors have shown that the system containing ketoglutaric acid, ammonium chloride, alcohol, cozymase, alcohol dehydrogenase (yeast), and glutamic dehydrogenase (liver) yields acetaldehyde and glutamic acid. It is suggested that the reversible formation of iminoglutaric acid, acetaldehyde and dihydrodehydrogenase from glutamic acid, ethyl alcohol, and dehydrogenase are coupled reactions, the significance of which in the animal organism is discussed.

---

17 Giri, K. V. (1938), *Indian Jour. Med. Res.* **25**, 869.

18 Adler, E., Das, N. B., Von Euler, H., and Heym  n, U. (1938), *Compt. rend. trav. lab. carlsberg.*, **22**, 15.

19 Adler, E., Das, N. B., and Von Euler, H. (1938), *Arkiv. kemi. min. geol.*, **12** B. No. 40, p. 5.



In another communication<sup>20</sup> Euler, Adler, Gunther and Das have reported that 1-Glutamic acid is reversibly converted into iminoglutaric acid by a apodehydrogenase of liver in presence of cozymase or codehydrogenase II—the iminoacid being subsequently hydrolysed into  $\alpha$ -ketoglutaric acid ammonia. The synthesis and transformation of aminoacids in the animal organism are discussed.

Damodaran and Nair<sup>21</sup> have investigated the properties of glutamic acid dehydrogenase from germinating seeds. It is found that the enzyme is present in seedlings of *Phaseolus mungo*, *Phaseolus radiatus* and *P. sativum*. The enzyme can be prepared from aqueous extracts free from cellular material by precipitation with ammonium sulphate and redissolution in phosphate buffer. The enzyme is found to oxidise naturally occurring 1-glutamic acid, thus differing from deaminases of animal origin (cf: 17, 18 and 11). It catalyses the oxidation in presence of methylene blue or oxygen. Arsenate, cyanide or fluoride do not inhibit the activity of the enzyme, nor is it activated by ascorbic acid, glutathione, or dihydroxyphenylalanine. The end product of the enzymic oxidation is found to be  $\alpha$ -ketoglutaric acid, which has been identified as the 2 : 4—dinitrophenylhydrazone.

Das<sup>22</sup> has shown that kidney tissue and top yeast contain a thermolabile activator for the enzymic oxidation of dl-alanine. The activator is found to be destroyed by heating to 80–85°C. at pH 8.0.

Ganapathy<sup>23</sup> has shown the presence of SH—SS redox system in the fresh latex of *Carica papaya*, by continuous aeration at pH 7.4, with and without preliminary heating. It is found that the SH concentration in the first case falls continuously, while in the second case it remains constant for a period and then falls. The addition of ascorbic acid is found to have no effect on the course of the reaction.

---

20 Euler, H. V., Adler, E., Gunther, G., and Das, N. B., (1938), *Zeit. physiol. chem.*, **254**, 61.

21 Damodaran, M. and Nair, K. R. (1938), *Biochem. J.*, **32**, 1064.

22 Das, N. B. (1938), *Naturwissenschaften*, **26**, 168.

23 Ganapathy, C. V. (1938), *Current Science*, **6**, 451.



(b) *Oxidases or aerobic oxidases* :

Ghosh and Guha<sup>24</sup> have described the properties, conditions of activity, specificity, and the effect of certain reagents on the action of the ascorbic acid oxidase from white gourd (*Benin casacriapra*).

From the Biochemical laboratory, Cambridge, Bhagvat and Richter<sup>25</sup> have published a paper in which they have described their investigations on animal phenolases. They have examined a number of animal tissues for the presence of phenolases of the catechol oxidase type. A crystalline Cu-protein complex which is catalytically active has been isolated from the blood of *Cancer paguras*. It is found that haemocyanins and other Cu-protein complexes can act as pseudo-phenolase and that they are mainly responsible for the apparent phenolase activity in a number of arthropods and molluscs. The highest phenolase activity is found in the group of arthropods and molluscs. The catalytic activities of Cu, Fe, Co, Ni and Mn. in the oxidation of a series of phenols have been investigated by the authors.

**General.**

With a view to throwing more light on the therapeutic properties of cobra venom, Iyengar, Sehra and Mukerjee<sup>26</sup> have investigated the nature and action of proteases present in the venom. The rate of digestion of casein by cobra venom in the concentration of 0.05 per cent has been followed by estimation of nonprotein N released at definite intervals. The amount of casein digested is found to be proportional to the square root of the duration of digestion. The optimum pH lies in the neighbourhood of 8.0. The protease is found to be inactivated by HCN and KCN. The protease therefore belongs to the group of tryptases. Papainases and pepsinases are not found to be present in the venom. The authors have found a trypsin inhibitor in the venom, which retards the further hydrolysis of the substrate, and it is suggested that the zinc salts present in the venom may be associated with the trypsin inhibitor.

24 Ghosh, B., and Guha, B. C. (1938), *J. Indian Chem. Soc.*, **14**, 721.

25 Bhagvat, K., and Richter, D. (1938), *Biochem. J.* **32**, 1397.

26 Iyengar, N. K., Sehra, K. B., and Mukerji, B. (1938), *Ind. J. Med. Res.*, **26**, 487.



Roy and Chopra<sup>27</sup> have investigated the nature and the concentration of the different enzymes that are present in snake venoms. It is found that the venoms of Russell's viper and cobra do not contain invertase or diastatic enzymes but they are found to possess the property of digesting fibrin, liquefying gelatin, clotting blood and digesting casein. The proteolytic activity of the viper venom is more than that of cobra venom.

In a subsequent communication, Roy<sup>28</sup> has reported the results of his investigations on the lypolytic activity of the venoms of cobra and Russell's viper. The venoms are found to have no action on olive oil. Cobra venom is found to possess a fairly strong esterase activity as judged by its capacity to hydrolyse ethylbutyrate, while viper venom has no appreciable action on the ester even in concentrated solutions. The esterase activity and the haemolytic action are not related to each other. Thus the esterase activity is destroyed when the venom is kept at 56° C. for half an hour, while the haemolytic activity is not much affected by this treatment. Lecithinase is found to be present in both the venoms, viper venom being stronger in action. The author finds a close parallelism between the lecithinase activity and haemolysin formation in the presence of lecithin. None of the venoms is found to have any appreciable action in splitting up cholesteryl oleate.

In connection with their investigations on the pharmacological action and therapeutic properties of the hydrocupreidine derivatives, Mukerji and Iyengar<sup>29</sup> have studied the comparative inhibitory action of a number of dextro-rotatory hydrocupreidine derivatives and their corresponding levo-rotatory isomers on the activity of salivary and pancreatic amylases and on yeast invertase. Levo-rotatory hydrocupreins are found to be more powerful inhibitors to the amylases than the dextro-rotatory hydrocupreins, and quinine is found to be weaker than the higher members of levo-rotatory hydrocupreins but stronger than the dextro-rotatory hydrocupreidines. The lower members of the

---

27 Roy, A. C., and Chopra, R. N. (1938), *Ibid.* **26**, 241.

28 Roy, A. C. (1938), *Ibid.* **26**, 249.

29 Mukerji, B., and Iyengar, N. K. (1938), *Ibid.* **26**, 289.



hydrocupreidines are found to possess no inhibitory action on invertase activity, while the higher homologues (from butyl-derivative upwards) are found to be more potent in this respect. The author's attempt to explain the mechanism of the observed inhibition as being due to the interaction of the alkyl radicals ( $\text{CH}_2$  groups) with the active groups of the amylases. In the case of invertase inhibition, the mechanism is found to be different from that of the amylases.

Chatterjee, Ghosh and Chopra<sup>30</sup> have shown that the anthelmintic activity of the seeds of *Butea Frondosa*, is related to the proteolytic enzyme present in the seeds. The enzyme is found to hydrolyse peptones and casein, and liquefy gelatin, but it has no action on ovalbumin or fibrin. The seeds also contain a lipolytic enzyme, which hydrolyses olive, castor and rape seed oils.

The subject of enzymes in honey has been studied rather extensively for a number of years, much of the work having been undertaken with a view to finding means for detecting adulteration. The evaluation of honey on the basis of its diastase content is now being adopted in analytical practice. Giri<sup>31</sup> has therefore investigated the diastatic content of Indian honey samples, in order to set standards by which the purity of honey could readily be ascertained. It is found that all the honey samples examined have diastatic numbers ranging from 5.0 to 10.0, and are below the lowest permissible limit for unheated honeys. It is suggested that the low values obtained for Indian honeys may be due to the high temperatures ruling in the places where the honey has been collected. The author has also shown that an enzyme which hydrolyses sodium glycerophosphate into inorganic phosphorus occurs in honey. The enzyme is found to be active at a pH range of 4.5 to 6.5, and it is activated by magnesium. Fermented honey samples are found to be characteristically high in phosphatase activity, while the values for unfermented samples are decidedly low. The phosphatase activity and the diastatic number decrease on pasteurising honey. It is

<sup>30</sup> Chatterjee, N. R., Ghosh, S. and Chopra, R. N. (1938), *J. Indian Chem. Soc.*, **15**, 101.

<sup>31</sup> Giri, K. V. (1938), *Madras Agric. Jour.*, **26**, 68.



suggested that honey phosphatase is derived chiefly from fermentation yeast and bees and partly from the plants.

### Methods.

Ganapathy and Sastri<sup>32</sup> have indicated the use of the photo-electric colorimeter for the study of the kinetics of some dehydrogenase reactions.

Bhagvat<sup>33</sup> has described an enzyme method for the estimation of adrenaline in suprarenal glands. The method is based on the oxidation of adrenaline by the enzyme to a red coloured compound. It is found that the colour formation takes place between pH 4.4 and pH 7.6 and that the colour is more stable in the acid range. The method is sensitive to 1 : 500,000 concentration of adrenaline. The author finds that there is good agreement between the biological and enzymic methods, while the chemical method is found to give variable results.

---

32 Ganapathy, C. V. and Sastri, B. N. (1938). *Current Science*, **6**, 334.

33 Bhagvat, K. (1938). *Ind. Jour. Med. Res.*, **33**, 911.



### III. HUMAN PATHOLOGY AND BACTERIOLOGY

*By S. M. Banerji*

While presenting this review of the investigations carried out in India in 1938 on human pathology and bacteriology, it seems necessary to offer an explanation as to why certain papers dealing with normal blood pictures have been incorporated in it. The figures for standard normal haematology obtained by different workers, working in various parts of the country vary so widely that a knowledge of the limits of such variation is essential for a haematologist in order to assess whether a certain value is normal or otherwise. The same difficulty is encountered by nutritional workers while dealing with deficiency diseases. Under such circumstances, it was considered advisable to incorporate the above material in the present review.

The subject matter has been arranged under the following heads :—

#### **I. Human Pathology.**

1. Blood. 2. New growths. 3. Special pathology. 4. Protozoal and metazoal infections. 5. Bacterial and virus infections. 6. Metabolic and deficiency diseases. 7. Miscellaneous.

#### **II. Bacteriology and parasitology.**

1. General. 2. Bacteria and allied organisms. 3. Animal parasites.

#### **I. HUMAN PATHOLOGY.**

##### **1. Blood.**

Sokhey, Gokhale, Malandkar and Billimoria<sup>1</sup> have given the normal *blood picture* of 101 healthy young women of Bombay to be as follows:

R. B. C. 4.47 millions; Haemoglobin 12.99 gm % (Oxygen capacity method); Cell volume 36.27 c.c. %; Haemoglobin co.

---

<sup>1</sup> Sokhey, S. S., Gokhale, S. K., Malandkar, M. A. and Billimoria, H. S. (1938), *Ind. Jour. Med. Res.*, **25**, 723.



efficient 14.55 gm %; Volume co-efficient 40.61 %; Colour index 1; Volume index 1; Saturation index 1.

Sankaran and Rajagopal<sup>2</sup> have studied the *haemoglobin value* of healthy young men and women in Madras by using Baker and Bing's modification of Wu's method and their value for men is 16.57 gm % (standard deviation 2.08, co-efficient of variation 12.5 %) and for women 13.73 gm % (standard deviation .93, co-efficient of variation 6.7%)

The same authors<sup>3</sup> have found a rise of *haemoglobin value* from 16.35 to 20.34 and from 13.69 to 18.44 by administration of ferrous sulphate. The rise was obtained within 14 days and subsided within 2 months.

Sankaran and Rao<sup>4</sup> have, by a modified technique of Hynes and Martin measured the *R.B.C. diameter* of 25 normal men and women with the following results :

Mean diameter  $6.85\mu$

Range of value  $6.27\mu$ . to  $7.38\mu$ .

Standard deviation  $.28\mu$ .

Co-efficient of variation 4.1 %

The figures are decidedly lower than the value obtained by Price Jones.

Rao<sup>5</sup> has estimated the *haemoglobin content* of 100 pregnant and 100 nonpregnant women at Coonoor (6000 ft. above sea level) by Bing and Baker's modification of Wu's method and has obtained the values of 15.52 gm and 15.81 gm % respectively. He has not found any relation between haemoglobin content and age, parity and duration of pregnancy nor are the figures in pregnancy much less than the general female population.

Sankaran and Rajagopal<sup>6</sup> have studied the *rise in haemoglobin value* due to high altitude and have found that after arrival at

<sup>2</sup> Sankaran, G. and Rajagopal, K. (1938), *Ind. Jour. Med. Res.*, **25**, 741

<sup>3</sup> Sankaran, G. and Rajagopal, K. (1938), *Ibid.*, **25**, 753

<sup>4</sup> Sankaran, G. and Rao, M. V. R. (1938), *Ibid.*, **25**, 951

<sup>5</sup> Rao, M. V. R. (1938), *Ibid.*, **25**, 957

<sup>6</sup> Sankaran, G. and Rajagopal, K. (1938), *Ibid.*, **25**, 971



Coomoor at 6000 ft. above sea level the haemoglobin value rises from 12.84 gm. to 20.38 gm.

Napier and Majumdar<sup>7</sup> have continued their studies on the haematological findings in cases of *anaemia* in pregnant tea garden coolie women. The anaemia is of 2 types :—microcytic hypochromic and macrocytic hyperchromic. The former type, in common with the general female population, is due to iron deficiency and low calcium and vitamin C in their diets. The latter is associated with deficiency of Vitamin B complex.

Crappier and Kahali<sup>8</sup> have given *adult haemoglobin standards* in Burma but the figures are low, viz., 14.39, 14.69 and 14.89 for males and 12.23, 13.03, and 13.9 for females.

Chaudhury and Mangalik<sup>9</sup> have given statistical survey of 2400 cases of confinements in which the incidence of *anaemia* was 5.6%. The common type was macrocytic hyperchromic with high mean corpuscular volume of 90 c.m. and high mean corpuscular haemoglobin of over 30, low leucocyte count and positive indirect *Van den Bergh* reaction.

Rajam and Tampi<sup>10</sup> have reported on three cases of *depressed bone marrow function* due to arsphenamine, two of them proving fatal. They showed hypoplastic and aplastic changes in blood and bonemarrow. The blood picture was:—diminished R. B. C. count, marked leucopenia with very low polymorphonuclear count. Bone marrow smear showed the differential count to be :

against the normal figures (Napier)

Erythroblasts	1.1 %	Erythroblasts	25 %
Mylocytes	1.1 %	Mylocytes	5.7 %
Lymhocytes	77 %	Lymhocytes	6.2 %
Plasma cells	6.3 %	Plasma cells	.6 %
Eosinophiles	12 %	Eosinophiles	4.7 %
Basophils	.5 %	Basophils	.2 %
Undetermined	2 %	Neutrophils	40 %

7 Napier, L. E. and Majumdar, D. N. (1938), *Ind. Jour. Med. Res.*, **28**, 541.

8 Cropper, C. F. J. and Kahali, B.S. (1938), *Ind. Med. Gaz.*, **73**, 139

9 Chaudhury, R. N. and Mangalik, V. S. (1938), *Ibid*, **73**, 257

10 Rajam, R. V. and Tampi R.B. (1938), *Ibid*, **73**, 337



Chatterji<sup>11</sup> has shown relationship of *anaemia in pregnancy* to various factors, e.g., age incidence (greatest between 20 to 29), period of pregnancy (starting as early as the third month), to season (rainy seasons showing greater incidence), etc.

Chatterji and Ghosh<sup>12</sup> have studied the biochemistry of blood in cases of *anaemia of pregnancy* and have found marked increase in globulin due to euglobulin factor, decrease in blood cholesterol, ester factor being affected the most.

De and Trivedi<sup>13</sup> have reviewed three cases of *acute lymphatic leucaemia* in children with details of signs and symptoms. No evidence of infection could be obtained in these cases. The histological picture of blood and lymphatic glands were typical. One case simulated acute rheumatism.

Mukerji<sup>14</sup> has described a case of *Cooley's anaemia* in a Bengali Hindu boy aged 30 months in Calcutta. The blood picture was as follows.

	On admission	Before death
R. B. C.	2.5 millions	1.1 millions
Haemoglobin	45 %	16 %
W. B. C	13000	12000
Polymorphs	70 %	70 %
Lymphocytes	42 %	24 %
Large Mono	4 %	2 %
Eosinophile	0 %	4 %

Nucleated R. B. C. found.

The X'ray photographs of bones are given as they confirmed the diagnosis in the case.

Chaudhuri and Mangalik<sup>15</sup> have described cases of idiopathic iron deficiency hypochromic *anaemia*, where iron and not liver is the proper remedy.

11. Chatterji, H. N. (1938), *Ind. Med. Gaz.*, **73**, 267.

12. Chatterji, H. N. and Ghosh, S. M. (1939), *Proc. 26th Indian Sci. Cong.*, Part 3, p. 161.

13. De, M. N. and Trivedi, B. P. (1938), *Ind. Jour. Pediatrics*, **5**, 129.

14. Mukerji, M. (1938), *Ibid*, **5**, 1.

15. Chaudhuri, R. N. and Mangalik, V. S. (1938), *Jour. Ind. Med. Ass.*,



Minchin<sup>16</sup> has reported a case of *typhus* with symptom of haematuria which showed a low platelet count. With improvement in the clinical condition, the count began to rise.

Seshadrinath and Annamali<sup>17</sup> have studied the blood picture of *septicaemic plague* in which they found degenerative changes in the white cells and relative increase of mononuclears.

## 2. New Growths.

Tropy<sup>18</sup> has reported a case of *hypernephroma* with metastases in os calcis and in the brain which ended fatally. The symptoms were a painful heel and haematuria only. The post mortem findings of the tumours are given.

Cruickshank<sup>19</sup> has given an account of a case of *thyroid metastasis* in the skull simulating meningioma.

Dey<sup>20</sup> has described a case of *breast cancer* in a male.

De<sup>21</sup> has given description of a case of *gastric cancer* in a girl of 19.

## 3. Special Pathology.

Napier *et al*<sup>22</sup> have studied the *gastric acidity* of various communities in Calcutta in health and disease. They have found that the gastric acidity is not lower than European standards. Cases with high acidity was associated with epigastric pain and those with low acidity with diarrhoea. Anaemia cases were always found to be hypoacid.

Ghosh, Roy and Mukerji<sup>23</sup> have carried on *gastric analysis* by alcohol method which they find to give results identical to results

---

16 Minchin, R. L. H. (1938), *Ind. Med. Gaz.*, **73**, 679.

17 Seshadrinath, N. and Annamali. (1939), *Proc. 26th. Ind. Sc. Cong.* Part 3, p. 160.

18 Torpy, C. D. (1938), *Ind. Med. Gaz.*, **73**, 414.

19 Cruickshank, M. M. (1938), *Ibid*, **73**, 656.

20 Dey, A. C. (1938), *Ibid*, **73**, 223.

21 De, A. C. (1938), *Ibid*, **73**, 224.

22 Napier, L. E., Chaudhuri, R. N. and Raichaudhuri, M. N. (1938). *Ind. Med. Gaz.*, **73**, 65.

23 Ghosh, J. L., Roy, B. B. and Mukerji, S. (1938), *Cal. Med. J.*, **33**, 51.



obtained by oatmeal gruel method. The caffeine method was also investigated but the authors do not arrive at any conclusion on account of the small number of cases.

Rao<sup>24</sup> has drawn attention to the common incidence of *peptic ulcer* in Northern Circars as revealed from statistical records of the Vizagapatam Medical College. The relation of incidence to various factors such as age, sex and occupation are discussed and the following are found to be the most probable causes:—pyorrhoea; irregular meals, dyspepsia and constipation; deficiency of vitamins A and B and malarial infection.

The same author<sup>26</sup> has found the bisulphite binding substances in blood of *peptic ulcer* patients to be increased in a good percentage of cases and therefore suggests a relation between gastric ulcer and deficiency of vitamin B.

Kaikini<sup>25</sup> has reported 5 cases of *regional Ileitis* which is apt to be confused with appendicitis, intestinal tuberculosis, colitis or malignancy. The morbid anatomy of the affection is that 10 to 12 inches of the ileal end is thickened and inflamed and the mesentery is found to be thick and fibrotic with enlarged glands. Oval mucous membrane ulcers are found. They may open in various ways. Microscopically, the picture is of a low grade inflammation with widespread oedema and mild cellular reaction in which lymphocytes, plasma cells monocytes and a few eosinophiles are found.

Rao and Rao<sup>27</sup> have given post mortem findings and histological reports of 5 cases of *biliary hepatic sclerosis*, cholangitic and mixed types. A wide intrahepatic nonsuppurative pericholangitis is the presclerotic condition. Uniform hepatomegaly, fine granularity, subepithelial pericholangitic round cell infiltration with narrowing of lumen, pericholangitic sclerosis and fibrous thickening of Glisson's capsule, bilestaining and bile capillary stasis without pseudo-lobulation are some of the principal characteristics.

---

24 Rao, M. N. (1938), *Ind. Med. Gaz.*, **73**, 454.

25 Rao, M. N. (1938), *Ibid*, **73**, 457.

26 Kaikini, V. M. (1938), *Ibid*, **73**, 214.

27 Rao, P. R. and Rao, M. V. R. (1938), *Jour. Ind. Med. Ass.*, **7**, 491.



Tirumurthi and Murthi<sup>28</sup> have begun investigations on the possibility of causing, in experimental animals, *biliary cirrhosis* of liver by administration, over long periods, of ricinoleic acid and ricin of castor oil.

Murthi<sup>29</sup> has summarised and discussed the published records of *infantile cirrhosis* of liver.

Viswanathan<sup>30</sup> has found in 14 out of 50 cases of *asthma bronchiectasis* by X-ray photographs after lipiodol injection.

Chaudhuri<sup>31</sup> has reported a case where there was spontaneous *subarachnoid haemorrhage* due to rupture of a congenital aneurism.

Achuthan and Kelu<sup>32</sup> have reported a case of *ulcerative endocardities* which was characterised by an abrupt onset, simulating malarial ague, and by a rapid course, death occurring within 34 hours. The diagnosis could only be made by a post mortem examination.

#### 4. Protozoal and Metazoal infections.

Sivalingam<sup>33</sup> has made a study of 50 cases of *Benign Tertian infection* by counting the parasites in c.m.m of blood in order to find the relation of the numbers of attacks of fever. He has found such a relation in primary cases only and his findings suggest that an upper limit of 10,000 m.p and lower limit of 900 m.p per c.m.m. of blood can cause an attack of fever.

De and Seal<sup>34</sup> have described a case of *malignant tertian malarial infection* where there was paralysis of the facial nerve.

Sami<sup>35</sup> has drawn attention to the high incidence of *hydatid disease* in south-west Punjab and has discussed the etiological factors.

---

28 Tirumurthi, T. S. and Murthi, K.N. (1939), Proc. 26th Ind. Sc. Cong, Part 3, p. 157.

29 Murthi, K. N. (1939), *Ibid*, Part 3, p. 158.

30 Viswanathan, R. (1938), *Ind. Med. Gaz.*, **73**, 138.

31 Chaudhuri, R. N. (1938), *Ibid*, **73**, 466.

32 Achuthan, A. and Kelu, M. (1938), *Ibid*, **73**, 740.

33 Sivalingam, V. (1938), *Ind. Med. Gaz.*, **73**, 715.

34 De, M. N. and Seal, S. C. (1938), *Ind. J. Pediatrics*, **5**, 8.

35 Sami, M. A. (1938), *Ind. Med. Gaz.*, **73**, 90.



## 5. Bacterial and virus infections.

Venkatraman and Pandit<sup>36</sup> have described a severe epidemic of *cholera* in Madura district of South India by vibrio of Ogawa type of Gardan and Venkatraman.

Pasricha *et al*<sup>37</sup> have investigated the reaction of *cholera* stools and have found 65% of them to be alkaline in reaction and 35% acid. The alkaline stools were without faecal matter and nearly all of them showed vibrios, whereas a much smaller proportion of acid stools showed vibrios.

Hasset<sup>38</sup> has given an account of an epidemic of *cholera* in Swat state. Chatterji<sup>39</sup> and Malik have failed to isolate *v. cholera* from urine of 122 cases of cholera. The urine of the acute cases was found to be highly acid, pH ranging from 4.4 to 5.4, and the urine became normal as symptoms improved.

Chatterji<sup>40</sup> has studied the pathological changes in haemolymph organs in *cholera* and has found dilated blood capillaries in bone marrow filled with R.B.C., enlargement of spleen with engorged red pulp and hyperplastic lymph nodules. Liver showed dilated sinusoids filled with R.B.C. Thymus and mesenteric lymph glands also showed marked hyperplasia.

The same author<sup>41</sup> has studied the pathology of the alimentary canal in *cholera*. Inflammatory and ulcerative lesions were not found but capillary dilatation of the mucous and submucous coats were met with and there was hyperplasia of the solitary lymph follicles.

The same author<sup>42</sup> has also found changes in the endocrine organs such as thyroid, suprarenals and pituitary in *cholera*. The intense capillary dilatation observed in bonemarrow, spleen, heart

---

36 Venkatraman, K. V. and Pandit, C. G. (1938), *Ind. Jour. Med. Res.*, **25**, 585.

37 Pasricha, C. L., Chatterji, D. N. and Malik, K. S. (1938) *Ind. Med. Gaz.*, **73**, 346

38 Hasset, (1938), *Ibid*, **73**, 602.

39 Chatterji, D. N. and Malik, K. S. (1938), *Ibid*, **73**, 612.

40 Chatterji, H. N. (1939), *Proc. 26th. Ind. Sc. Cong. part 3*, p. 189

41 Chatterji, H. N. (1939), *Ibid*, page 161.

42 Chatterji, H. N. (1939), *Ibid*, page 161



muscles, mucous membrane of the intestines explain the shock-like symptoms of the disease.

Greval *et al*<sup>43</sup> have carried out, in a group of unselected Indian and European patients in the Carmichael hospital for tropical diseases in Calcutta, the Wasserman test by "method No. 4" of the Medical Research Committee (1918), reinforced by 2 additional antigens. They have found 10 % of cases to be strongly positive, suggestive of *latent syphilis*. The remaining cases giving positive results must have been due to other conditions than syphilis. No racial difference was found. The authors lay stress on the importance of the effect of syphilis on tropical diseases and vice versa.

Iswariah and Nair<sup>44</sup> have described an *endemic spirochaetal affection* of children and women, which is not venereal. Differential diagnosis between such affections and yaws and syphilis is discussed and the authors are inclined to the view that the affection is a different one.

Das Gupta<sup>45</sup> has reported 6 cases of *leptospiiral jaundice* in Calcutta each of which was confirmed by laboratory examination. The causal organism, which was isolated in 2 cases, was found to be *L. icterohaemorrhagic* strain of Europe. The disease occurred sporadically, though the incidence of natural infection with the leptospira is low in the rodent population in Calcutta.

Trivedi and De<sup>46</sup> have studied *dysenteric* infection amongst Europeans in Calcutta. The prevalence is without any seasonal variation. The Indian menial staff acting as carriers is strongly suspected as the most probable source of infection. In majority of cases the type of dysentery is bacillary, mainly Flexner but also *Ps. Pyocyaneae*, *Bact. Morgani*, *B. Carolinus* and *B. Faecalis Alcaligenes*. Amoebic cases are rarer and in stool examination, the authors point out, it is important to remember that amoebae lose their motility very soon and that association of Charcot-Leyden crystals with amoebiasis is slight.

43 Greval, S.D.S., Sengupta, P. C. and Das, B. C. (1938), *Ind. Med. Gaz.*, **73**, 585.

44 Iswariah, V. and Nair, V. G. (1938), *Jour. Ind. Med. Ass.*, **7**, 651.

45 Das-Gupta, B. M. (1938), *Ind. Med. Gaz. Br.* **73**, 449.

46 Trivedi B. P. and De M. N. B. (1938), *Med. Jour.* 7th May 1938, p. 1000.



Lowe<sup>47</sup> has found racial differences in symptoms of *leprosy* and has suggested a study of racial susceptibility in the various affected races towards leprosy.

Mody<sup>48</sup> has reported a case of *Staphylococcus polyarthritidis*, where the organism was isolated by blood culture.

## 6. Metabolic and deficiency diseases.

Pasricha, Lal and Malik<sup>49</sup> have investigated into the changes in the sp. gravity of the serum of *epidemic dropsy* patients. Sp. gravity of healthy serum ranges between 1.0256 and 1.0275 with a mean value of 1.0263; whereas the specific gravity of serum of epidemic dropsy cases varies between 1.0140 to 1.0235 with a mean value of 1.0223. With subsidence of oedema, the sp. gr. returns towards normal levels.

Ray and Ganguly<sup>50</sup> have demonstrated that the urine of *epidemic dropsy* cases shows diminished excretion of inorganic phosphates, chlorides and calcium.

Lal, Ahmad and Roy<sup>51</sup> have, in continuation of their work in connection with epidemiology of *epidemic dropsy* investigated the part played by allyl isothiocyanate. They find that 90% of the allyl-iso-thiocyanate, present in mustard oil and *ol sinapis*, is volatilised in the process of cooking. Attempts at producing symptoms resembling epidemic dropsy by feeding animals with mustard oil and *ol sinapis* failed. Human subjects, taking food cooked in oil containing 2,517 mgm. of allyl-iso-thiocyanate for a month, showed no symptoms. The authors therefore conclude that the deleterious substance present in mustard oil and responsible for producing symptoms of epidemic dropsy is not allyl-iso-thiocyanate.

Lal<sup>52</sup> has reiterated his mustard oil theory as the cause of *epidemic dropsy* though regarding the identity of the toxic substance,

---

47 Lowe, J. (1938), *Ind. Med. Gaz.*, **73**, 591.

48 Mody, M. S. H. (1938), *Ibid*, **73**, 287.

49 Pasricha, C.L., Lal, S. and Malik, R. S. (1938), *Ind. Med. Gaz.*, **73**, 283.

50 Ray, S. N. and Ganguly, R. (1938), *Ind. Jour. Med. Res.*, **26**, 465.

51 Lal, R. B., Ahmad, B. and Roy, S. C. (1938), *Ibid*, **26**, 213.

52 Lal, R. B. (1938), *Cal. Med. Jour.*, **34**, 169.



further work is necessary. The difficulty lies in experimenting on animals with chemical toxins.

Bhaduri<sup>53</sup> has reported a case of *epidemic dropsy* where there was enormous reduction of intra-ocular tension in one eye following trephining of the other eye.

Bhaduri and Biswas<sup>54</sup> have found that in *epidemic dropsy* cases there is relatively greater rise of tension after dark adaptation than in normal eyes.

De and Bhattacharji<sup>55</sup> have found that the average velocity of glycolysis in drawn blood of *diabetics* is definitely less than in normal blood.

Sharma<sup>56</sup> has made observations on *sugar tolerance* of healthy aged Indians and has found 5 types of cases. Storage defect is common and the renal threshold is raised in old age.

Rao<sup>57</sup> has studied the relation of vitamin C content of blood to *peptic ulcer* and has come to the conclusion that deficiency of the vitamin is not an etiological factor.

Raman<sup>58</sup> has given a summary of 21 cases of *pellagra* in Vizagapatam. There was anaemia in most cases. The blood chemistry showed low protein content and low cholesterol values, but sugar calcium and phosphate values were normal. The urine showed normal diastase content but the porphyrin content was very high.

Giri<sup>59</sup> *et al* have studied the serum phosphatase activity as a test for *rickets* in groups of rats fed on different diets. The phosphatase activity was found to be better with basal diets than in those supplemented with calcium lactate and was still better if the basal diet was supplemented with fats.

Pal and Singh<sup>60</sup> have found *hypofunction of the thyroids* in experimental animals fed on basal diet supplemented by phosphorus alone, though so such change was found when calcium was added.

33 Bhaduri, B. N. (1938), *Ibid*, **34**, 532.

54 Bhaduri, B. N. and Biswas, C. N. (1938), *Ibid*, **34**, 206.

55 De, P. and Bhattacharji, S. (1931), *Ind. Jour. Med. Res.* **25**, 923.

56 Sharma, G. L. (1931), *Jour. Ind. Med. Ass.*, **7**, 641.

57 Rao, M. N. (1938), *Jour. Ind. Med. Res.*, **26**, 170.

58 Raman, T. K. (1939), *Proc. 26th Ind. Sc. Cong.*, part **3**, p. 159.

59 Giri, K. V., Shourie, K. L. and Rajagopal, K. (1939), *Ibid*, p. 165.

60 Pal, R. K. and Singh, N. K. (1938), *Ind. Jour. Med. Res.*, **25**, 693.



Rao<sup>61</sup> has found varying degrees of degeneration of myelin sheath of peripheral nerves in experimental animals reared on vitamin A deficient diets.

## 7. Miscellaneous.

Mangalik and Stott<sup>62</sup> have discussed the incidence of *rheumatism* in India and have come to the following conclusions:—

(i). Acute types are rare, chronic and mild types being more common.

(ii). Valvular disease of the heart is very common, though pericardial incidence is rare. Septic tonsils are very common.

(iii). Age incidence is between 10 to 35 years, conforming to the European type and males are more affected.

Gollerkeri<sup>63</sup> has described four cases of subcutaneous nodules resembling histologically the *rheumatic* type.

Stott<sup>64</sup> has found from post mortem records in India that *rheumatic endocarditis* is quite common in this country. The figures are 2.2% of all post mortems and 14% of all post mortems of diseases of the circulatory systems.

Cruickshank<sup>65</sup> has supplied details of a case of *oxycephaly* in Madras.

Torpy<sup>66</sup> has reported 2 cases of suspected *botulism*.

Kini and Kesavaswamy<sup>67</sup> have reported a case of *spondylolisthesis* between the 4th and the 5th lumbar vertebra, completely sacralised. There were cervical ribs on both sides.

Raghavachari and Venkataramanan<sup>68</sup> have carried on investigations on the *fluoride* content of waters of Nellore and other districts and have found mottling of the enamel of teeth of experi-

61 Rao, M. V. R. (1938), *Ind. Jour. Med. Res.*, **25**, 661.

62 Mangalik, V. S. and Stott, H. (1938), *Ind. Med. Gaz.*, **73**, 203.

63 Gollerkeri, P. G. (1938), *Ibid*, **73**, 207.

64 Stott, H. (1938), *Ibid*, **73**, 330.

65 Cruickshank, M. M. (1938), *Ibid*, **73**, 595.

66 Torpy, C. D. (1938), *Ibid*, **73**, 600.

67 Kini, M. G. and Kesavaswamy, (1938), *Ibid*, **73**, 658.

68 Raghavachari, T. N. S. and Venkataramanan, K. (1939), *Pro. 26th Ind. Sci. Cong. part 3*, p. 158.



mental animals after 3 to 4 weeks of administration of water with 50 p. p. m. of fluoride.

Phipson<sup>69</sup> has given an account of a case of *adrenal insufficiency* which had symptoms like Adams-Stoke's disease.

Chakraverty and Tyagi<sup>70</sup> have studied the effects of *heat stroke* in 10 persons on the biochemical changes in blood. They have found a tendency towards retention of nitrogenous constituents, and inorganic phosphates and lowered blood calcium. The lactic acid content and anions increased in blood but there was low chloride both in blood and urine. The changes are suggestive of renal inefficiency.

Chakravarti<sup>71</sup> has discussed *ecclamsia* in Bengal with reference to its incidence (—age, period of pregnancy—etc.), mortality and the factors responsible, seasonal variation and treatment.

Mitra and Ghosh<sup>72</sup> have found a definite relationship between prevalence of *ecclampsia* in Bengal and the season, high humidity being the most important single factor.

## BACTERIOLOGY AND PARASITOLOGY

### 1. General.

Maplestone and Dey<sup>73</sup> have studied the *fungistatic and fungicidal activity of various drugs* as well as their bacteriostatic action and have found the following to be the best in their effects *in vitro*: Merfenil, Brilliant Green and Crystal Violet.

Chopra and Roy<sup>74</sup> have studied the effect of *Seitz filters* on haemolysins. The components of a haemolytic system, lose their haemolytic property when passed through such filters but not when passed through Berkefield filters through a layer of kieselguhr. The authors therefore caution against the use of asbestos filters in investigations with bacterial toxins.

69 Phipson, E. S. (1938) *Ind. Med. Gaz.*, **73**, 277

70 Chakraverty, D. N. and Tyagi, N. (1938), *Ind. Jour. Med. Res.*, **25**, 791

71 Chakravarti, J. (1938), *Cal. Med. Jour.*, **34**, 387

72 Mitra, S. and Ghosh, T. K. (1938) *Ibid*, **34**, 283

73 Maplestone, P. A. and Dey, N. C. (1938), *Jour. Ind. Med. Res.*, **25**, 603.

74 Chopra, R. N. and Roy, A. C. (1938), *Ibid*, **26**, 303.



Lahiri<sup>75</sup> has tried combining antigens with various nonspecific substances such as alum, tapioca and calcium chloride in order to increase their power of producing antiserums. A combination of tapioca and calcium chloride with the antigen produces a very powerful tetanus antiserum and a combination of alum with the antigen produces a very powerful diptheria antiserum.

Ray and Das<sup>76</sup> have investigated the effect of a combination of tapioca and calcium salts with the antigen for the production of high titre tetanus and diptheria antisera.

Lahiri<sup>77</sup> has criticised the utility of Ramon's flocculation test in the standardisation of tetanus antitoxin.

Swaroop<sup>78</sup> has discussed the problem of numerical estimation of *B. Coli* by the dilution method. A suitable method is given, with tables attached to simplify calculation.

Vardon and Datta-Roy<sup>79</sup> are of opinion that papain casein digest media are satisfactory for the preparation of bacteriophages, cholera and other organisms.

Greval *et al*<sup>80</sup> have discussed the ordinary methods of assaying Wasserman reaction and have suggested a better one.

Biswas<sup>81</sup> has found the normal serum globulin to possess stronger affinity for H-ions than antibody globulin, by filtration with strong alkali, though this difference cannot be shown by filtration with different acids and weak alkalies.

Deo<sup>82</sup> has found the finer grades of coarse candles of Filter Chamberland Systeme Pasteur preferable for bacteriophage work.

Basu, Ray and Ghosh<sup>83</sup> have demonstrated Danysz phenomena with v. septique toxin anti-toxin by the guinea pig intracutaneous method.

75 Lahiri, D. C. (1938), *Ibid*, **26**, 310.

76 Ray, N. N. and Das, G. C. (1938), *Ibid*, **26**, 317.

77 Lahiri, D. C. (1938), *Ibid*, **26**, 345.

78 Swaroop, S. (1938), *Ibid*, **26**, 353.

79 Vardon, A. C. and Datta-Roy, B. K. (1938), *Ibid*, **26**, 379.

80 Greval, S. D. S., Das, B. C. and Sen Gupta, P. C. (1939), *Ibid*, **26**, 393.

81 Biswas, M. M. (1938), *Ind. Jour. Med. Res.*, **26**, 469.

82 Deo, L. R. S. (1939), *Proc. 26th Ind. Sci. Cong.*, part 3, p. 163.

83 Basu, P. N., Roy, M. N. and Ghosh, S. M. (1938), *Cal. Med. Jour.*, **34**,



Raghavachari and Iyer<sup>84</sup> have given a simple and economical modification of the techniques of M. R. and V. P. tests used in *bacteriological examination of water*.

The same authors<sup>85</sup> have studied McConkey's test at 44° C as an *index of pollution in water analysis* and have come to the conclusion that the test cannot be relied on in India for differentiating faecal from non-faecal organisms.

Chatterji and Deo<sup>86</sup> have discussed the factors controlling *activity of bacteriophages* and have given description of the method adopted in their laboratory for filling medicinal phials with bacteriophage suspensions.

Ray and Das<sup>87</sup> have studied the effect of *antigen injection, plain and in combination* with alum, tapioca, calcium chloride and manganese chloride, on production of anti-tetanus serum in horses and have found that tapioca and manganese chloride combination gave highly potent sera.

## 2. Bacteria and Allied Organisms.

Linton, Mitra and Seal<sup>88</sup> have studied the effect of treatment of young smooth cultures of *Cholera* vibrios with their homologous activated anti-serum. The effect is that the smooth changes to the rough type, serologically more generalised than the smooth ones. The authors have further investigated the changes undergone by the strains in respect of their chemical structure, metabolism and physical condition such as electrophoresis by such treatment with their anti-sera. The original strains were case strains, belonging to groups I, II and VI, possessing protein I; and water and carrier strains of groups III, IV and V possessing protein II. Group IV differs from groups I and II in the polysaccharide content. Treatment with homologous antiserum changes the groups to

---

84 Raghavachari, T. N. S. and Iyer, P. D. S. (1939), Proc. 26th Ind. Sci. Cong., part 3, p. 162.

85 Raghavachari, T. N. S. and Iyer, P. D. S. (1939), *Ibid*, 163.

86 Chatterji, S. K. and Deo, L. R. S. (1939), *Jour. Ind. Med. Ass.*, **8**, 141.

87 Ray, N. N. and Das, G. C. (1938), *Ind. Jour. Med. Res.*, **25**, 617.

88 Linton, R. W., Mitra, B. N. and Seal, S. C. (1938), *Ibid*, **26**, 329.



group IV with protein II and polysaccharide I and the metabolism changes to that of group IV. Electrophoresis changes show increased surface tension of the strains as a result of the treatment.

Linton, Shrivastava and Seal<sup>89</sup> have studied the specific polysaccharide groups of *Cholera Vibrios* and the effect of growth media on them and have demonstrated that there is a limited capacity for transformation within the framework of 2 proteins and 3 polysaccharides.

Taylor and Ahuja<sup>90</sup> have been successful in isolating *Cholera vibrios* in 90 out of 91 samples of unprotected river, well and tank waters but they did not agglutinate with pure 'O' serum nor well with 'H' and 'O' sera. It is suggested that the vibrio therefore do not play any part in the aetiology of Cholera.

Pasricha, Chatterji and Das<sup>91</sup> in Calcutta have isolated *vibrio Cholera* from samples of surface water of river Hooghly, and tanks and from flies and cockroaches, not agglutinating with 'O' serum but some with 'H' and 'O' sera. Tube well and municipal pipe waters were found to be free from the vibrio.

Pandit and Mitra<sup>92</sup> have found *Cholera* vibrio in 90% cases of open water sources in Assam.

Linton, Shrivastava, Seal and Mukerji<sup>93</sup> have studied the chemistry and serology of specific polysaccharide groups of the *vibrios of Cholera* and have found the presence of two chemically and serologically different types among the cholera strains. In fresh strains the polysaccharides are conjugated with lipoids and it is the latter, which dominate specificity. In older strains, the lipoid complex is absent and the nitrogen and acetyl percentages differ, though the strain is serologically positive to 'O' antiserum.

Maitra, Sen Gupta and Thant<sup>94</sup> have described an autochthonous epidemic of *Cholera* in a Rangoon jail, confirmed by bacteriological

---

89 Linton, R. W., Shrivastava, and Seal, S. C. (1938), *Ind. Jour. Med. Res.*, **25**, 569.

90 Taylor, J. and Ahuja, M. L. (1938), *Ibid*, **26**, 1.

91 Pasricha, C. L., Chatterji, D. N. and Das, P. C. (1938), *Ibid*, **26**, 33.

92 Pandit, S. R. and Mitra, A. M. (1938), *Ibid*, **26**, 39.

93 Linton, R. W., Shrivastava, D. L., Seal, S. C. and Mukerji, S. P. (1938), *Ibid*, **26**, 41.

94 Maitra, G. C., Sen-Gupta, P. N. and Thant, U. (1938), *Ind. Med. Gaz.*, **73**, 406.



examination. The prevailing type was 'Inaba' type but one case was due to the 'Ogawa' type.

Pasricha, DeMonte and Chatterji<sup>95</sup> have described a case of *Cholera* in which on the third day of the disease there was acute enlargement of liver and jaundice. From the material obtained from liver puncture, was isolated 'O' agglutinable smooth vibrio cholera indistinguishable from the vibrio isolated from stool culture.

Pasricha, Chatterji and Paul<sup>96</sup> have given the results of their examination of 14 samples of *Cholera vaccine*. The vaccines were tested for sterility, freedom from abnormal toxicity, antigenic response, in rabbits and men and guineapigs. Six of them, prepared from recognised laboratories, gave satisfactory antigenic response and protected guinea pigs against 2 m. l.d of cholera vibrio. 4 only out of 8 commercial preparations were satisfactory.

Pasricha, Lahiri and Das<sup>97</sup> have isolated in 3 instances typical *Cholera vibrios* from stools of non-cholera individuals out of 2000 such examinations.

DeMonte and Gupta<sup>98</sup> have failed to isolate *Cholera vibrios* by blood culture.

Stewart and Ghoshal<sup>99</sup> have isolated in 8 instances *B. Typhosus* from 75 samples of water of river Hooghly by using Wilson and Blair's bismuth sulphite medium and have found greater incidence of the bacilli during the Ardhoday Joga festival. The risk of using the river water has been emphasised.

Raghavachari and Iyer<sup>100</sup> have studied the longevity of *Coliform organisms* in Adyar river water, stored under natural conditions and have isolated Clamesha's class I (the variety, supposed to be susceptible to sunlight and storage) after a long time.

95 Pasricha, C. L., DeMonte, A. J. A. and Chatterji, B. C. (1938), *Ind. Med. Gaz.*, **73**, 405.

96 Pasricha, C. L., Lahiri, M. N. and Paul, B. M. (1938), *Ibid*, **73**, 463.

97 Pasricha, C. L., Lahiri, M. N. and Das, P. C. (1938), *Ibid*, **73**, 669.

98 DeMonte, A. J. A. and Gupta, S. K. (1938), *Ibid*, **73**, 670.

99 Stewart, A. D. and Ghoshal, S. C. (1938), *Ind. Jour. Med. Res.*, **25**, 591.

100 Raghavachari, T. N. S. and Iyer, P. D. S. (1939), *Proc. 26th Ind. Sci. Cong.* part 3, p. 162.



Sen<sup>101</sup> has demonstrated *Meningococcus bacteriophage* to undergo no deterioration in contact with serum and in his experience intravenous and intrathecal injections gave encouraging clinical results.

Sen<sup>102</sup> has studied the *Meningococcus bacteriophage* production in various culture media and has shown that the phage, though most active at 5°C, is not destroyed until 60°C is reached. Phage introduced intravenously in gradual doses does produce antiphage but in single larger doses it is effective. Clinically, good results are obtained by the intravenous use of the phage.

The same author<sup>103</sup> has studied 100 strains of *Meningococci* of Calcutta epidemic origin and has classified the atypical ones into 4 different groups. Passage through mice is a valuable method of identifying the atypical strains. Red pigments extracted from strains isolated from cerebro-spinal fluid are spectroscopically different from those obtained from strains isolated from other sources. Pleomorphic forms of atypical strains have been studied.

Dharmendra and Lowe<sup>104</sup> have attempted to cultivate *M. Leprae muris* by various methods and have obtained unsatisfactory results.

Pandit, Rao and Shortt<sup>105</sup> have continued their studies on the response of the chorio-allantoic membrane of the developing chick embryo to inoculation with various organisms, specially with *B. Proteus X19* and have compared the results. They have drawn attention to the presence of a gram-negative bacillus in the membranes and heart blood of uninoculated living embryos.

Lahiri<sup>106</sup> has come to the conclusion, as a result of his investigations, that for prevention and treatment of *Gas gangrene*, antitoxic anti-Welchii serum is infinitely superior to antibacterial serum. He recommends antitoxins of classical Welchii A type as suitable for treatment of infections of man.

Goyal<sup>107</sup> has given the results of his serological study of the *Actinomyces*. He has found methyl alcohol extract to be suitable for

---

101 Sen, B. B. (1938), *Ind. Jour. Med. Res.*, **26**, 335.

102 Sen, B. B. (1938), *Cal. Med. Jour.*, **34**, 502.

103 Sen, B. B. (1938), *Ibid*, **33**, 205.

104 Dharmendra, and Lowe, J. (1938), *Ind. Jour. Med. Res.*, **25**, 845.

105 Pandit, C. G., Rao, R. S. and Shortt, H. E. (1938), *Ibid*, **25**, 595.

106 Lahiri, D. C. (1938), *Ibid*, **26**, 401.

107 Goyal, R. K. (1938), *Ibid*, **25**, 843.



complement fixation test and has suggested that the actinomyces should be classified as schizomycetes.

Bose and Saha<sup>108</sup> have made a detailed study of *Staphylococcus Pyogenes* with reference to their exotoxin, anatoxin and antitoxin.

Menon<sup>109</sup> has isolated *Staphylococcus Aureus* from vaccine lymph and has tested their pathogenicity and toxicity.

Rao<sup>110</sup> has described the cultivation of *sheep pox virus* on the chorio-allantoic membrane of the developing egg and the lesions produced thereby.

Veeraraghavan and Philipsz<sup>111</sup> have been unsuccessful in their attempt to cultivate the *Rabies virus* on the chorio-allantoic membrane of the developing egg.

Shortt, Pandit and Rao<sup>112</sup> have been able to culture the *virus of Sandfly fever* by the chorio-allantoic membrane technique and tissue culture. The sera of patients, recovered from sand fly fever have been shown to possess the power of neutralising the cultured virus. Animal inoculation showed inconclusive results. The size of the virus has been determined to be about  $160\mu\mu$  in diameter.

Ghosh, Bose and Mukerji have studied the *bacterial flora of Dahi* and have found various organisms besides lactic acid bacilli. The type of B. acid lactic, which was found, had little or no action on the growth of various pathogenic organisms.

Pasricha, Lal and Goyal<sup>114</sup> have studied the *bacteriology of curdled milk* and have found Lactobacilli resembling L. Acidophilus, Streptococcus Lactis, and yeast cells. Bacteriological examination of the faeces, after feeding with curdled milk and lactose, could not, however, reveal the presence of Lacto bacilli and therefore in these cases there was no evidence of the implantation of the Lacto bacilli.

---

108 Bose, H. N. and Saha, M. N. (1938), *Jour. Ind. Med. Ass.*, **7**, 585.

109 Menon, K. P. (1939), *Proc. 26th Ind. Sci. Cong.*, part 3, p. 163.

110 Rao, R. S. (1938), *Ind. Jour. Med. Res.*, **26**, 497.

111 Veeraraghavan, N. and Philipsz, G. L. C. (1938), *Ibid*, **26**, 493.

112 Shortt, H. E., Pandit, C. G. and Rao, R. S. (1938), *Ibid*, **26**, 229.

113 Ghosh, H., Bose, S. K. and Mukerji, S. M. (1938), *Cal. Med. Jour.*, **33**, 297.

114 Pasricha, C. L., Lal, S. and Goyal, R. K. (1938), *Ind. Med. Gaz.*, **73**, 94.



Bhatnagar<sup>115</sup> has concluded Vi agglutination to be a more reliable method of *diagnosing Typhoid fever* in the inoculated than the 'O' and 'H' types of agglutination. The employment of Vi agglutination in the routine carrier examination and in tracing source of typhoid infection is suggested. In every case of typhoid, Vi antibody is produced but the inoculated individual shows a higher titre.

DasGupta<sup>116</sup> has studied *experimental Ratbite fever* in man and in laboratory animals. Infection could not be produced by contact or feeding. Litters born of infected mothers (mice) did not show infection. The W. R. reaction was negative in infected human beings but positive in infected guinea pigs. Man is immune to further infection after an attack of experimentally produced ratbite fever.

### 3. Animal Parasites.

Theodar<sup>117</sup> has studied various types of *sandflies (phlebotomus)* from Siam, Ceylon and Malay.

Buxton<sup>118</sup> has described *an apparatus* in which a rodent and a population of fleas (*Xenopsylla Cheopis*) may be maintained in natural conditions, capable of control and measurement, thus affording better facilities for studying their biology.

Roy<sup>119</sup> has studied the number of eggs of the common varieties of *house flies* in Calcutta.

Sen<sup>120</sup> has furnished a note regarding the overwintering of the *housefly Musca domestica*.

Rishworth<sup>121</sup> has reported on an adult *filarial worm* of unknown species removed from the skin of a human subject. It is provisionally named by the author *Loa inquirenda*.

115 Bhatnagar, S. S. (1938), *Brit. Med. Jour.*, 10th Dec. 1938.

116 Das-Gupta, B. M. (1938), *Ind. Med. Gaz.*, **73**, 14.

117 Theodar, O. (1938), *Ind. Jour. Med. Res.*, **26**, 261.

118 Buxton, P. A. (1938), *Ibid.*, **26**, 505.

119 Roy, D. N. (1938), *Ibid.* **26**, 531.

120 Sen, P. (1938), *Ibid.* **26**, 535.

121 Rishworth, H. R. (1938), *Ind. Med. Gaz.*, **73**, 7.



Maplestone<sup>122</sup> has added a note describing the features of the specimen.

Syddiq<sup>123</sup> has given a detailed account with excellent photographs of the *eye fly* *Siphunculina funicula*. The organisms isolated from these flies were staphylococci aureus, non-haemolytic streptococci, enterococci and diptheroids.

Roy<sup>124</sup> has reported the finding of *Bertiella studeri*, a natural *tapeworm* parasite of monkeys, in the stool of a Hindu child of Barisal.

Ali<sup>125</sup> has made a survey of *rat-flea* in Mattanchery, Cochin, where in 1937 an outbreak of plague occurred after many years. His findings are summarised below:—

Out of 291 rats,	267	were	<i>R. rattus</i>
	14		<i>R. Norvogenicus</i>
	7		Bandicoots
	3		Musk rats.
Out of 705 fleas	480	were	<i>X. Astia</i>
	44		<i>X. Cheopis</i>
	179		<i>X. Braziliensis</i>

122 Maplestone, P. A. (1938), *Ind. Med. Gaz.*, **73**, 8.

123 Syddiq, M. M. (1938), *Ibid*, **73**, 17.

124 Roy, S. C. (1938), *Ibid*, **73**, 346.

125 Ali, P. M. (1938), *Ibid*, **73**, 409.



## IV. FOODS AND NUTRITION

*By S. Ranganathan and A. R. Sundararajan.*

The steady progress in this field reported in the preceding years has been maintained during the year under review. The papers published cover numerous aspects of the subject of nutrition. The material for review is divided, for the sake of convenience, into the following sections :—

- (1) The nutritive value of foodstuffs.
- (2) General Nutrition,
- (3) Deficiency diseases,
- (4) Biochemical studies,
- and (5) Miscellaneous.

### 1. The Nutritive Value of Foodstuffs.

(a) *Chemical Composition of Foodstuffs*: Subrahmanyam *et al* studied the effect of milling on the chemical composition and commercial qualities of raw and parboiled rices. They found that, as a result of parboiling, the total nitrogen content of hulled rice increased slightly while that of phosphorus remained practically unaffected. With the same degree of milling, parboiled rice was richer in nitrogen and phosphorous than raw rice. Again, parboiled rice whether polished or unpolished, lost less nitrogen and phosphorous on washing than comparable samples of raw rice; also, comparatively less of water-soluble constituents passed out into the 'conjee' on cooking parboiled rice. Coloured and coarse-grained varieties of rice were found to be richer in proteins and minerals, particularly phosphorus, than fine-grained varieties.<sup>2</sup> Such rices require a greater degree of polishing than the others before obtaining a white (polished) grain. Polishing results

---

1 Subrahmanyam, V., Sreenivasan, A. and Das-Gupta, P. (1938), *Ind. Jour. Agri. Sci.*, **8**, 459.

2 Sadasivan, V. and Sreenivasan, A. (1938), *Ibid*, **8**, 817.



in a loss of about 30% in fat, 25% in proteins and 50% in ash constituents of the rice grain.

Rao<sup>3</sup> looks upon rice as a colloidal system intermediate between the lyogel and the xerogel. During the later stages of maturing of paddy, the lyogel loses water with a drift towards the xero state. Rice from freshly harvested paddy does not cook well and is not properly digested, because the drift to the xero state has not advanced sufficiently. The cooking of freshly harvested rice to a pasty consistency is ascribed by Sreenivasan<sup>4</sup> as due to the presence in the grain, immediately after harvest, of a fairly active  $\alpha$ -amylase, which during storage passes into a dormant condition.

Majumdar and De<sup>5</sup> determined the oxalic acid content of some 52 common Indian foodstuffs, the values ranging from 0.5 for bitter gourd to 1,336 mg. per 100 g. for rhubarb stalk. Sundararajan<sup>6</sup> found that in cereals the proportion of the total phosphorus present as phytin phosphorus is high while vegetables contain little or no phytin; the condiments and spices occupy an intermediate position. Giri<sup>7</sup> found on an examination of some 62 foods that a large part (50 to 70 percent) of the phosphorus of cereals was in the phytin form, not available for nutrition. Pulses, oil seeds and nuts contained 20 to 60 per cent in this form while green leafy vegetables were devoid of it. Immature grains contained less phytin phosphorus than mature ones.

The nutritional requirements of iron have become complicated by the introduction of the concept of 'available' or ionisable iron, which alone is stated to be assimilated in the system. Ranganathan<sup>8</sup> found on an examination of some 100 common Indian foodstuffs for total and 'available' iron that leafy vegetables, condiments and spices, usually considered rich sources of iron, have low percentages of 'available' iron. Goswami and Basu<sup>9</sup> arrived at roughly the same

---

3 Rao, B. S. (1938), *Curr. Sci.*, **6**, 446.

4 Sreenivasan, A. (1938), *Ibid*, **6**, 614.

5 Majumdar, B. N. and De, N. K. (1938), *Ind. Jour. Med. Res.*, **25**, 671.

6 Sundararajan, A. R. (1938), *Ibid*, **25**, 685.

7 Giri, K. V. (1938), *Ibid*, **25**, 869.

8 Ranganathan, S. (1938), *Ibid*, **25**, 677.

9 Goswami, H. and Basu, U. P. (1938), *Ibid*, **25**, 893.



conclusions though, as regards individual values, differences are to be found in the results of the two workers. The total iron content of a foodstuff varies greatly from place to place. The effect of such variations in the computation of the iron content of human dietaries was demonstrated by Ranganathan.<sup>10</sup> In the laboratory determination of the total iron content, special precautions are taken to avoid iron contamination and only figures obtained with such care are reported in food value tables. Calculations of the iron content of diets from such figures will not take into account the accretion of iron through contamination during storage and preparation of foods, which may often be considerable. Hence, it is felt that the calculation of the total iron content of dietaries from standard food value tables is of very dubious value.

Ranganathan and Narasimhamurty<sup>11</sup> investigated the chemical composition of various types of 'buttermilk'. They found a slight loss of nitrogen when fermentation was prolonged. Non-protein nitrogen increased with souring.

Buffalo's colostrum has a higher specific gravity, acidity, sodium chloride, total solids, total protein, casein, albumin, globulin and ash content than cow's colostrum, while in lactose content it is lower.<sup>12</sup> Buffalo's colostrum changes to normal milk in about 3 days while cow's colostrum takes about 5 days.

Cystine is absent in both chillies and coriander while tryptophane and histidine are present in them in only small amounts<sup>13</sup>.

Gupta and Lal<sup>14</sup> made a chemical examination of the seeds of cape gooseberry (*Physalis peruviana*)

(b) *Vitamin content of Foodstuffs*: Basu and De<sup>15</sup> found the vitamin A potency of the liver oils of *ruhee* and *hilsa* fish to

10 Ranganathan, S. (1938), *Ind. Jour. Med. Res.*, **26**, 119.

11 Ranganathan, S. and Narasimhamurty, G. (1938) *Agri. & Livestock in India*, **8**, 421.

12 Sivasubramaniam, V. and Dover, C. W. (1938), *Ind. Jour. Vet. Sci. and Anim. Husb.*, **8**, 29.

13 Narasimhamurty, G. (1938), *Ind. Jour. Med. Res.*, **25**, 863.

14 Gupta, M. P. and Lal, J. B. (1937), *Proc. Nat. Acad. Sci., India*, **7**, 131.

15 Basu, K. P. and De, H. N. (1938), *Ind. Jour. Med. Res.*, **26**, 197.



be 461 and 120 I. U. per g., as determined by the biological method; the potency of the body oil of *ruhee* was 109 while that of the *hilsa* was nil. Employing the spectrographic method for vitamin A and the colorimetric method for carotene, De *et al*<sup>16</sup> determined the vitamin A activity of some 30 fish oils and 45 vegetable foodstuffs. Some of the Indian fish liver oils tested were more potent in vitamin A than Norwegian cod liver oil.

In general, the vitamin A and carotene content of foodstuffs is not affected to any appreciable extent by boiling them in water containing sodium bicarbonate or tamarind.<sup>17</sup>

"The remarkable resistance of vitamin A in ghee to the action of heat and air and the divergent results obtained by others" led Banerjee<sup>18</sup> to the conclusion, "that other natural pro and anti-bodies present in ghee were partly responsible for the results." Acidity in ghee, whatever be the cause of its development, was highly pro-oxidant and would destroy vitamin A very rapidly. De and Majumdar<sup>17</sup> (*loc. cit.*) reported appreciable losses of vitamin A during the melting of butter to ghee. Banerjee and Doctor<sup>19</sup> describe the optimum conditions for the manufacture of butter from cream and its later conversion into ghee. They report that the indigenous method of preparation of ghee, while it gives a rich aroma, increases its acid value, a factor highly detrimental to the keeping quality and vitamin A content of ghee. Grewal and Kochhar<sup>20</sup> report a higher vitamin A value for summer butter fat than for the winter butter fat; also that butter fat sold in the Lahore market is grossly adulterated.

Wilson and Roy<sup>21</sup> determined the flavine and vitamin B<sub>6</sub> (antidermatitis factor) content of some 90 Indian foodstuffs. Pulses and leafy vegetables are good sources of both factors while fruits are poor in them.

---

16 De, N. K., Majumdar, B. N. and Sundararajan, A. R. (1938), *Ind. Jour. Med. Res.*, **26**, 435.

17 De, N. K. and Majumdar, B. N. (1938), *Ibid*, **25**, 857.

18 Banerjee, B. N. (1938), *Agri. & Livestock in India*, **8**, 153.

19 Banerjee, B. N. and Doctor, N. S. (1938), *Ibid*, **8**, 158.

20 Grewal, K. S. and Kochhar, B. D. (1938), *Ind. J. Med. Res.*, **25**, 623.

21 Wilson, H. E. C., and Roy, G. K. (1938), *Ibid*, **25**, 879.



Swaminathan<sup>22</sup> has evolved a colorimetric method of estimating nicotinic acid in foodstuffs based on the colour reaction of the pyridine group with cyanogen bromide and aniline. The low values for peas and fenugreek seeds show that trigonelin, the methylbetain of nicotinic acid, does not probably interfere in the estimation of nicotinic acid by this method.<sup>23</sup> The method is stated to be sensitive and capable of detecting 0.01 mg. of nicotinic acid.

The ascorbic acid content of several varieties of Indian chillies (*capsicum*) was determined and appreciable differences were found in different samples of the same variety.<sup>24</sup> The formation of ascorbic acid was at its highest when the chillies were ripe.

Ramasarma<sup>25</sup> estimated the carotene and ascorbic acid content of some 30 varieties of mangoes, the figures found corresponding roughly to those reported by others. In a subsequent paper<sup>26</sup> in collaboration with another author, it was stated in the body of the paper that mango is a rich source of vitamin C but the figures given in the tables do not bear this out.

## 2. General Nutrition.

Wilson and Mitra<sup>27</sup> report that the diet of the well-to-do classes in Calcutta approximates in most respects to the European standards, while that of the Assam coolie is deficient in total calories, total and animal protein, total and animal fat, calcium and carotene. The incidence of caries is greatest among the well-to-do and least among the poor Assam coolies while that of mal-occlusion of teeth is reversed. In a diet survey carried out on 51 families in Ferozepur (Punjab), it was found that the intake of calories, fat, protein, calcium and phosphorus is adequate, though the intake of animal protein is low and possibly inadequate for growth, pregnancy and

---

22 Swaminathan, M. (1938), *Nature*, **141**, 830.

23 Swaminathan, M. (1938), *Ind. Jour. Med. Res.*, **26**, 427.

24 Rothenheim, C. A., Mohammud, H. S. S. and Cowlagi, S. S. (1938), *Jour. Ind. Chem. Soc.*, **15**, 15.

25 Ramasarma, G. B. (1938), *Proc. Soc. Biol. Chem., India*, **3**, 16.

26 Banerjee, B. N. and Ramasarma, G. B. (1938), *Agri. & Livestock in India*, **8**, 253.

27 Wilson, H.E.C. and Mitra, D. D. (1938), *Ind. Jour. Med. Res.*, **26**, 131



lactation.<sup>28</sup> As the bulk of the diet is composed of wheat, having a high content of phytin phosphorus, the authors question whether the requirement of phosphorus is fully met. Mitra<sup>29</sup> studied the dietary habits of some communities living at Calcutta, making use of an "index", which has been taken as the ratio of the number of times a particular item of food is consumed each day to the number of persons consuming it. In a diet survey of some 20 healthy Sikh soldiers, it was found that their diet was adequate in respect of total protein, fat, mineral salts and vitamins; only 7% of the total protein was of animal origin.<sup>30</sup>

Mhaskar<sup>31</sup> has evolved a balanced diet, suitable to the needs of the people of India, for about Rs. 6 per adult per month. An enquiry into the diets of Bombay showed that while it was high in calories, it had only 3.5 and 2.7 per cent of animal fat respectively. The suggested diet is stated to contain 33 per cent of the total proteins in the form of animal protein and 34 per cent of the total fat as animal fat. Krishna and Mitra<sup>32</sup> found that the addition of fresh liquid skimmed milk and milk reconstituted from powder to the diet of day-school children produced an enhancement of growth and an improvement in the general condition. Seal<sup>33</sup> is of the opinion that general dietetic deficiency is more or less prevalent all over India and that the sub-clinical state of deficiency is the primary cause of the general ill-health and lowered resistance of the people to disease. On a South Indian middle-class dietary, partial deficiency of vitamin C is the rule and optimal intake the exception. The conclusions arrived at are much the same as those reported by Ranganathan and Sankaran (*Ind. Jour. Med. Res.* 1937, **25**, 29)<sup>34</sup>

Aykroyd *et al*<sup>35</sup> have applied the original A. C. H. method (measurements of arm, chest and hip) to groups of South Indian

---

28 Ahmad, B., and Gore, H.K. (1938), *Ind. Jour. Med. Res.*, **26**, 155.

29 Mitra, D. D. (1938), *Ind. Med. Gaz.*, **73**, 280.

30 Shourie, K.L. and Singh, N. (1938), *Ind. Jour. Med. Res.*, **25**, 655.

31 Mhaskar, K. S. (1938), *Med. Bull. Bombay*, **6**, 118.

32 Krishnan, B. G. and Mitra, K. (1938), *Ind. Jour. Med. Res.*, **25**, 647.

33 Seal, S. C. (1938), *Ind. Med. Gaz.*, **73**, 291.

34 Nair, K. R. (1938), *Curr. Sci.*, **7**, 324.

35 Aykroyd, W. R., Madhava K. B. and Rajagopal, K. (1938), *Ind. Jour. Med. Res.*, **26**, 55.



children. The authors very tentatively recommend this method for assessing the state of nutrition of South Indian children between the ages of 6 and 13. Its application to other age groups and in other parts of India requires further study.

*Basal Metabolism:* Rajagopal<sup>36</sup> determined the basal metabolism of some 25 Indian and 20 European men under identical climatic conditions and found that the Indian had on an average a basal metabolism 8 % below that of the European; this difference is probably due to a racial factor. Wilson and Roy<sup>37</sup> reported the basal metabolism of 62 boys in Calcutta of ages from 6 to 16; the figures were low compared to American standards. In view of the fact the boys examined belonged to the poorer classes, were underweight and on a low protein diet, the authors did not incline to the hypothesis that a racial factor was the cause of the low B. M. R. In this connection, Rahman's findings (*Ind. Jour. Med. Res.*, 1936, **24**, 173), reported in last year's Review, are of significance.

The wider the range of adaptability to climatic conditions the greater are the chances of the individual to keep healthy.<sup>38</sup>

### 3. Deficiency Diseases.

(a) *Angular stomatitis:* Aykroyd and Krishnan<sup>39</sup> found that the stomatitis occurring in boys living on a diet largely composed of milled rice was cured by consumption of eggs or of yeast autoclaved in an alkaline medium but not by soya-bean meal. They suggest that the factor curing stomatitis is identical with the P-P-factor.

(b) *Pellagra:* Lewis<sup>40</sup> claims to have treated pellagra successfully with intravenous injections of 10 c.c. of 10 per cent solution of sodium thiosulphate twice weekly.

---

36 Rajagopal, K. (1938), *Ind. Jour. Med. Res.*, **26**, 411.

37 Wilson, H. E. C. and Roy, C. N. (1931), *Ibid*, **25**, 901.

38 Ahmad, B., Lal, R. B. and Roy, N. C. (1938), *Ibid*, **26**, 204.

39 Aykroyd, W. R. and Krishnan, B. G. (1938), *Ibid*, **25**, 643.

40 Lewis, D. R. (1938), *Ind. Med. Gaz.*, **73**, 616.



(c) *Peptic ulcer*: M. N. Rao<sup>41</sup> found an increase in the bisulphite-binding substances in blood of peptic ulcer patients, revealing a definite deficiency of vitamin B in them. On the other hand, their blood has a normal ascorbic acid content; hence vitamin C deficiency is not probably an etiological factor in the formation of peptic ulcer.<sup>42</sup> Discussing the problem of peptic ulcer in the Northern Circars, the same author finds the following factors to be responsible for the causation of the disease: (1) irregularity in the intervals between meals and the variety of food, predisposing to dyspepsia and frequent pylorospasm; (2) partial avitaminosis giving rise to changes in the gastro-intestinal tract and (3) teeth and gastro-intestinal tract acting as septic foci leading to elective localisation of the organisms either in the stomach or duodenum.<sup>43</sup>

(d) *Epidemic dropsy*: Evidence was adduced in the last year's Review that the incriminating factor for the disease was mustard oil, particularly of inferior quality. Continuing their investigations on the active principle present in mustard oil, Lal *et al*<sup>44</sup> excluded allyl isothiocyanate. Food cooked in oil containing 2517 mg. of allyl isothiocyanate and consumed during a period of 30 days did not produce any ill-effects. Attempts to produce symptoms resembling epidemic dropsy in monkeys, rats and cats by feeding them with mustard oil from various sources were unsuccessful. The excretion of inorganic phosphates, chlorides and calcium in the urine of epidemic dropsy patients is lower than in the urine of normal subjects.<sup>45</sup> Palit and Basu<sup>46</sup> propound new ideas in the treatment of epidemic dropsy; exposure to sunlight and the consumption of a good diet, containing milk and adequate minerals, especially iron and calcium, and oils, butter and other foods irradiated by sunlight or ultra-violet light are the chief factors in curing and preventing the disease.

(e) *Anaemias of pregnancy*: A statistical survey of anaemias of pregnancy from the records of a maternity hospital shows that

41 Rao, M. N. (1938), *Ind. Med. Gaz.*, **73**, 457.

42 Rao, M. N. (1938), *Ind. Jour. Med. Res.*, **26**, 171.

43 Rao, M. N. (1938), *Ind. Med. Gaz.*, **73**, 454.

44 Lal, R. B., Ahmad, B. and Roy, S. C. (1938), *Ind. J. Med. Res.*, **26**, 213.

45 Ray, S. N. and Ganguly, R. (1938), *Ibid*, **26**, 465.

46 Palit, C. C. and Basu, S. N. (1938), *Jour. Ind. Med. Assn.*, **7**, 197.



in 2,400 confinements in 2 years, the incidence of anaemia was 5.6%.<sup>47</sup> It was more common in primiparae; its maximum age incidence was between 20 and 30 years. The macrocytic hyperchromic type was most common.

(f) *Vitamin A deficiency*: Histological examination of rats, rabbits and guinea pigs fed on diets deficient in vitamin A and carotene showed varying degrees of degeneration of the myelin sheaths of the spinal nerves.<sup>48</sup> While there was good evidence to show that vitamin A deficiency caused myelin degeneration, similar changes might also result from other dietetic deficiencies. Phrynoderma is, according to M. V. R. Rao<sup>49</sup>, probably a manifestation of a nutritional deficiency in which lack of vitamin A is an important factor. Vitamin A concentrate (Glaxo Laboratories, "Preparation A") effected cures in two advanced cases.

(g) *Mineral deficiency*: Supplements of calcium salts are recommended as a milk substitute when milk cannot be supplied.<sup>49a</sup> Children in a nursery school given a supplement of 0.5g. of calcium lactate daily showed greater increases in height and weight than children not receiving the supplement. The acceleration in growth was evidence of and accompanied by an improvement in general condition. Rats fed on a diet based on rice and representative of that of the poorer classes in South India did not grow; but did well when the diet was supplemented with 0.15 g. of calcium lactate daily.<sup>50</sup> Changes in the parathyroids indicative of hypofunction were noticed in the rats on the basal diet. The poor South Indian diet could thus be rendered more nutritive by the calcium supplement.<sup>51</sup> With such a supplement, the parathyroids returned to the normal condition. Addition of sprouted Bengal—gram and calcium, either individually or in combination, enhances the nutritive value of a

47 Choudhury, S. and Mangalik, V. S. (1938), *Ind. Med. Gaz.*, **73**, 257.

48 Rao, M. V. R. (1938), *Ind. Jour. Med. Res.*, **25**, 661.

49 Rao, M. V. R. (1938), *Ind. Med. Gaz.*, **73**, 461.

49a Aykroyd, W. R. and Krishnan, B. G. (1938), *Lancet*, 16th July 1938, 153.

50 Pal, R. K. and Singh, N. (1938), *Ind. Jour. Med. Res.*, **25**, 693.

51 Pal, R. K. and Singh, N. (1938), *Ibid*, **26**, 95.



poor North Indian diet.<sup>52</sup> A combination of both ingredients produces an algebraic sum of the effects due to each.

Addition of calcium to a Madras diet enhances the biological value of its proteins from 44 to 76 and its digestibility from 64 to 89.<sup>53</sup> The authors state that the Madras diet satisfies Sherman's standard of calcium requirements. It is unfortunate that the authors do not give any information about the composition of the diet except that rice formed the major item. Since rice has a biological value of 83, it seems unlikely that a diet constituted for the major part of rice should show only a biological value of 44. Investigating the mineral assimilation of growing calves, it was found that when the minerals are sufficient in the feed itself, a supplement of calcium phosphate does not show any visible effect.<sup>54</sup>

#### 4. Biochemical Studies.

Rudra<sup>55</sup> found more ascorbic acid in Bengal gram (*Cicer arietinum*) germinated in very weak solutions of manganese salts than in water.

Giri and Doctor<sup>56</sup> found that addition of 2% pyrophosphate to plant and animal materials during trituration for estimation of vitamin C gave consistently higher value in all cases than when pyrophosphate was not added. Similar results were found on addition of 2% metaphosphoric acid by Musulin and King (*Jour. Biol. Chem.*, 1936, **116**, 409).

Further evidence for the existence of ascorbic acid in a combined form, "ascorbigen", was adduced by Guha and Sen-Gupta.<sup>57</sup> Cabbage and certain animal tissues contain ascorbic acid in combined form and, in addition, a non-specific reducing substance also in combined form. The authors have outlined a method for the estimation of "total" ascorbic acid.

---

52 Pal, R. K. and Singh, N. (1938), *Ind. Med. Gaz.*, **73**, 469.

53 Ranganathan, V. and Rau, Y. V. S. (1938), *Nature*, **142**, 165.

54 Aiyar, A. V. and Aiyar, N. K. (1938), *Ind. Jour. Vet. Sci. and Ani. Hus.*, **8**, 43.

55 Rudra, M. N. (1938), *Nature*, **141**, 203.

56 Giri, K. V. and Doctor, N. S. (1938), *Ind. Jour. Med. Res.*, **26**, 165.

57 Guha, B. C. and Sen-Gupta, P. N. (1938), *Nature*, **141**, 974.



About 60 per cent of the carotene contained in the "poor Madrasi diet" was assimilated by rats.<sup>58</sup> Skimmed milk powder and calcium lactate, added as supplement to the above diet, produced acceleration of growth but showed no significant influence on the carotene adsorption. Carotene from grasses is mostly of the  $\beta$  variety:  $\beta$  carotene produces vitamin A in the physiological system in equivalent amounts, while  $\alpha$ — and  $\gamma$ —carotene produce vitamin A in only half the amount.<sup>59</sup> Increased carotenoid feeding helps to build up reserves of vitamin A in dairy cows and a slight increase in the milk supply. The physiology of the goat is different from that of the cow or buffalo in that it either converts carotene into vitamin A or rejects it.<sup>60</sup> No carotene xanthophyll could be detected in the blood or milk fat of goats even with rich carotenoid feeding.

Considerable variations were found in the calcium and phosphorus contents of the tissues of normal rats, the nature of the diet appearing to affect the values.<sup>61</sup> No relationship was found between the Ca: P ratio of the diet and the average values for calcium and phosphorus in the tissues. The lungs had the highest calcium content, followed by the brain, spleen, testes and lungs. The calcium content of muscle and spleen was increased in starvation, in the latter by about 120%. Sub-cutaneous administration of vitamin D proved more toxic than oral administration of a like amount.<sup>62</sup> Urinary excretion of calcium and phosphorus increased as a result of administration of vitamin D and continued to remain at a high level even during the period of partial decrease in food intake. Both calcium and phosphorus retention was reduced, the reduction in the case of phosphorus being the greater. More phosphorus was withdrawn from the bones than calcium, with the result that the Ca: P ratio was altered from 2.226 in normal rats to 2.585 in rats receiving vitamin D.

---

58 De, N. K. and Majumdar, B. N. (1938), *Ind. Jour. Med. Res.*, **26**, 441.

59 Makijani, J. K. and Banerjee, B. N. (1938), *Ind. J. Vet. Sci. & Ani. Hus.*, **8**, 13.

60 Banerjee, B. N. and Datta, N. C. (1938), *Agri. & Livestock in India*, **8**, 563.

61 Patwardhan, V. N. and Chitre, R. G. (1938), *Ind. Jour. Med. Res.*, **25**, 633.

62 Patwardhan, V. N. and Chitre, R. G. (1938), *Ibid*, **26**, 447.



Referring to Leitch's article on the determination of the calcium requirements of man (*Nut. Abst. and Rev.*, 1936, **6**, 553), Hye<sup>63</sup> prefers to combine the data for positive and negative balances with different intakes and to fit only one line. By doing so, he derives a maintenance requirement of 0.52 g. calcium daily instead of 0.55 g. as originally calculated.

## 5. Miscellaneous.

The population of pregnant tea-garden coolie women as a whole had a low level of haemoglobin associated with a pale red blood cell<sup>64</sup>. Conditioned iron deficiency brought about by continuous blood loss from hookworm infection with a coincident low iron intake, accounted for this in part, while the low calcium or a low vitamin C intake might also be associated factors.

The gastric acidity of normal Indians is above the British standard<sup>65</sup>. In Bengalees, an alcohol meal gave slightly higher readings for acidity than an oatmeal gruel meal<sup>66</sup>.

The faecal reaction of breast-fed babies was found to be acid whereas those fed on cow's milk showed an alkaline reaction<sup>67</sup>. The faecal reaction on a mixed Bengalee diet which included rice was acid while that on a *marwadi* diet with no rice tended to be alkaline. The exclusion of rice from Bengalee diet and its replacement by bread changed the reaction of the faeces from acid to alkaline.

In studies on the loss of fat during manufacture of butter from cream, it was found that when the concentration of fat in the cream was maintained at 30%, a minimum amount of fat was lost in the butter-milk<sup>68</sup>. The optimum temperature of ageing is 48 to 52°F. and that of churning the cream 54 to 56°F. Addition of citric

---

63 Hye, A. (1937), *Ind. Jour. Vet. Sci.*, **7**, 303.

64 Napier, L. E. and Majumdar, D. N. (1938), *Ind. Jour. Med. Res.*, **26**, 541.

65 Napier, L. E., Chaudhuri, R. N. and Chaudhuri, M. N. R. (1938), *Ind. Med. Gaz.*, **73**, 65.

66 Ghosh, J., Roy, B. and Mukherji, S. (1938), *Cal. Med. Jour.*, **33**, 45.

67 Pasricha, C. L., Goyal R. K. and Lal, S. (1938), *Ind. Med. Gaz.*, **73**, 141.

68 Francisco, J. S. (1938), *Agri. & Livestock in India*, **8**, 262.



acid or sodium citrate to the cream improves the flavour, aroma and keeping quality of the resulting butter.

Annaswamy and Paul<sup>69</sup> describe the optimum conditions for the manufacture of casein in India. Singh and Lal<sup>70</sup> give useful information on the composition and best methods of preservation of citrus fruit squashes. The authors report that potassium metabisulphite is a very satisfactory preservative and prevents even adverse colour changes.

The year under review witnessed the publication of two important documents on the improvement of Indian Agriculture, one by Sir John Russell<sup>71</sup> and the other by N. C. Wright<sup>72</sup>. The former, dealing with the work of the Imperial Council of Agricultural Research in applying science to crop production in India, touches upon the nutritional aspects of Indian agriculture. Wright's Report is a comprehensive survey of the dairy industry in India with a fund of valuable statistical information. The Report pleads that attention should be focussed on indigenous milk products like ghee, curds, etc., and not on table butter, cheese and the like; also on increasing the milk supply in the villages as distinguished from cities. For the improvement of the milk yields of Indian cows, Wright is emphatically against cross-breeding with foreign breeds and recommends the systematic building up of herds of high yielding, indigenous breeds of cows.

Mukherji<sup>73</sup> has brought out an excellent publication on "Food Planning for 400 millions." The author is well known for his many thoughtful works on Indian economics and sociology. The economics portions of the book are admirable but unfortunately the same

---

69 Annaswamy, S. and Paul, D. L. (1938), *Agri. & Livestock in India*, 8, 643.

70 Singh, L. and Lal, G. (1938), *Ind. Jour. Agri. Sci.*, 8, 77.

71 Russel, Sir John (1937), "Report on the work of the Imperial Council of Agricultural Research in applying science to crop production in India", Manager of Publications, Delhi.

72 Wright, N. C. (1937), 'Report on the Development of Cattle and Dairy Industries in India', Manager of Publications, Delhi.

73 Mukherjee, R. (1938), "Food Planning for 400 Millions," Macmillan & Co., Ltd., London.



cannot be said about the nutrition side of it. The book is replete with tables giving useful information.

The Madras Government has brought out an illuminating Report on their enquiry into the family budgets of industrial workers in Madras city.<sup>74</sup> The survey is based on an intensive study of families of labourers employed in both organised and unorganised industries. The material collected is subjected to thorough statistical analysis and the seventytwo pages devoted to appendices greatly enhance the utility of the Report.

---

74. Report on an Enquiry into the Family Budgets of Industrial Workers in Madras City (1938), Superintendent of Government Press, Madras.



## V. PROTEINS

By K. P. Basu.

During the year under review work has been done mainly on the biological value of proteins of foodstuffs, on the supplementary relations between proteins of mixed feed, on the extraction and chemical analysis of proteins and on the non-protein nitrogen of different foodstuffs. As European standards may not be applicable to Indians it is very important to carry out protein metabolism experiments on human beings in India, with a view to determining the protein requirements for balance and finding if the typical dietaries of poor people maintain the adults in protein balance and contain 50% margin over the minimum requirements as has been advocated by Sherman.

### 1. Biological value of Proteins.

Basu and De<sup>1</sup> have determined the biological values of fish proteins. The biological values of proteins of steam-dried ruhee fish (*Labeo rohita*) by the balance sheet method at 5, 10, and 15 per cent. levels of protein intake are 82.3, 78.9 and 72.5 respectively. The corresponding values for hilsa-fish (*Clupea ilisa*) proteins are 78, 69.5 and 62.1 per cent. The biological values of proteins of steam-dried ruhee fish by the growth method at 5, 10, and 15 per cent levels of protein intake, are 1.47, 1.55 and 1.71 respectively, while the corresponding values for the steamdried hilsa-fish proteins are 0.25, 1.32 and 1.48. Sun-dried fish is taken in some parts of India and sun-dried ruhee-fish meal has been found to have a higher value than the steam-dried meal both for the maintenance of nitrogen equilibrium and also for promoting growth in young rats. The sun-dried hilsa-fish meal does not possess any significant increased value for the maintenance of nitrogen equilibrium but has a higher value for promoting growth in young rats than the steam-dried meal. The digestibility of the sun-dried product is also greater.

---

1 Basu, K. P. and De, H. N. (1938), *Ind. Jour. Med. Res.*, **26**, 117.



Swaminathan<sup>2</sup> has published a summary of his results on the biological values of proteins of cereals, pulses, nuts, oilseeds and dried vegetables which he published during the last two years and which have been reviewed in the previous volumes.

## 2. Supplementary relations between proteins of different foodstuffs.

Biological values of mixtures of the millet ragi and pulse and of ragi, pulse and skimmed milk have been determined by Swaminathan<sup>3</sup> both by the balance sheet and by growth methods at 8 per cent. level of protein intake. The values obtained are fairly high and there is a supplementary relation in some but not in all cases as is claimed by the author. The supplementary relations would, however, have been more clear if the observed biological values had been compared with the calculated values for the mixtures.

Basu and De<sup>1</sup> found an appreciable supplementary relation between the proteins of ruhee (*Labeo rohita*) and proteins of the pulses, *Lathyrus sativa* and lentil, by the balance-sheet method. Marked supplementary effect of the proteins of the ruhee fish on the proteins of the pulses, lentil, *Lathyrus sativa* green gram, and field-pea in promoting growth was observed.

## 3. Extraction and analysis of proteins.

Proteins of chillies (*Capsicum annum*) and Coriander seeds (*Coriandrum sativum*) have been analysed by Narasimhamurthy<sup>4</sup>. In the case of chillies, the major portion of the nitrogen is extracted under conditions resembling those employed in cooking viz. extracting at 100°C with 0.3 per cent. salt solution. Of this 'available' nitrogen, over 40 per cent. is in the non-protein form.

Under similar conditions of temperature, pH and salt concentration, coriander seeds do not part with a corresponding proportion of their nitrogen. Cystine appears to be absent from both. Lysine is present in fairly good amounts in chillies. Both are deficient in tryptophane and histidine.

---

2 Swaminathan, M. (1938), *Ind. Jour. Med. Res.*, **26**, 113.

3 Swaminathan, M. (1938), *Ibid.* **26**, 107.

4 Narasimhamurthy, G. (1938), *Ibid.* **28**, 863.



Basu and De<sup>5</sup> extracted and analysed the proteins of the two varieties of fish *Labeo rohita* and *Clupea ilisa*. The globulin and glutelin constitute the major portion of the proteins in both cases. The aqueous extracts contain mostly globulin. Tyrosine, tryptophane, cystine and histidine are present in fairly good amounts.

#### 4. Non-protein nitrogen.

Swaminathan<sup>6</sup> has estimated the non-protein nitrogen of food-stuffs as the difference between total nitrogen and protein nitrogen which can be estimated by copper hydroxide (Stutzer's reagent). Cereals contain about 5 per cent., pulses, 9 per cent., nuts and oil seeds 5 per cent., condiments 6 per cent., vegetables 14 per cent. and milk 9 per cent. of non-protein nitrogen expressed as per cent. of total nitrogen. The non-protein nitrogen would give low values for the digestibility of the proteins of foodstuffs.

#### 5. Other Investigations.

The deamidizing activity of proteolytic enzymes has been studied by Damodaran and Anantanarayanan.<sup>7</sup> They find that during the action of pepsin or ereptic enzymes (amino-polypeptidase and dipeptidase) on casein, edestin and gliadin, the progressive liberation of ammonia and of amino-groups does not run parallel and the ammonia formed is mostly derived from the decomposition of the primary products of protein cleavage by the acid or alkali of the digestion media. Papain preparation, however, appears to possess deamidase activity and with it the ammonia formation is enzymic.

From peptic digests of casein carried out under conditions where bacterial contamination was excluded, tyrosine has been isolated by Damodaran and Krishnan<sup>8</sup> in yields amounting to 1.7–1.8% of the total tyrosine in the protein. The authors maintain that tyrosine produced by self-digestion of pepsin was negligible and that free amino-acids are liberated during the digestion of proteins by pepsin

---

5 Basu, K. P. and De, H. N. (1938), *Ind. Jour. Med. Res.*, **26**, 191.

6 Swaminathan, M. (1938), *Ibid*, **25**, 847.

7 Damodaran, M. and Anantanarayanan, P. (1938), *Biochem J.*, **32**, 1877.

8 Damodaran, M. and Krishnan, P. S. (1938), *Biochem J.*, **32**, 1919.



as claimed by Northrop and by Calvery and Schock. Different results have been obtained by Abderhalden and by Waldschmidt-Leitz and Kunster who maintain that pepsin can liberate complexes but not free amino-acids from proteins.

Preliminary reports about some investigations have appeared. Rau and Ranganathan<sup>9</sup> have determined the biological values of the total mixed proteins of Madrasi (vegetarian), Punjabi (non-vegetarian) and Bombay (Parsi non-vegetarian) dietaries by balance sheet experiments with rats and obtained the values 31, 39, 44, for Madrasi, 70, 69, for Punjabi and 58, 86 for Parsi diets. All the diets contained the minimum amount of Ca necessary for balance as determined by Sherman. Addition of  $\text{CaCO}_3$ <sup>10</sup> caused a slight increase in the biological values in the case of Punjabi and Parsi diets but a much greater increase in the case of the Madras diet. This result should be accepted with caution and requires confirmation. Unpublished work done in the reviewer's laboratory shows that calcium has little or no effect on the biological values of proteins.

Nitrogen elimination with protein free diets and S N: ratio in urine with protein-free and with rice and wheat diets have been determined by Basu, Basak and Haldar<sup>11</sup> in two adults. The nitrogen output on protein-free diet appears to be .05 gm. per kilo body-weight. The value of S:N ratio (= 1 : 8.5) on non-protein diet indicates that on such a diet the endogenous nitrogen metabolism represents the metabolism of non-protein nitrogenous constituents of the tissues whereas the fasting metabolism (S:N=1:14) is the result of disintegration of body protein. Almost equal amounts of ethereal sulphates were found both with rice and wheat diets while they were absent in the case of protein-free diet.

---

9 Rau, Y. V. S. and Ranganathan, V. (1938), *Proc. Soc. Biol. Chemists (India)*, **3**, 64.

10 Ranganathan, V. and Rau, Y. V. S. (1938), *Ibid*, **3**, 91.

11 Basu, K. P., Basak, M. N. and Haldar, M. K. (1939), *Proc. Indian Science Congress, Lahore*, Part 3, p. 26,



## VI. MICROBIOLOGY AND FERMENTATION

*By S. V. Desai.*

Rajagopalan<sup>1</sup> found that the groundnut nodule bacteria attacked all carbohydrates, including dextrin, producing the same final hydrogen ion concentration in the media at the end of a month. The order of fermentation was glucose, levulose, mannose, sucrose, raffinose, galactose, maltose, dextrin, xylose and lactose. The ferment power of the organisms ( $S : Ct$ , where  $S$  is the sugar consumed,  $C$  the cell weight and ' $t$ ' the period of incubation) was very high during the early stages of growth, and subsequently diminished rapidly with advance in age of the culture. This indicated the existence of two distinct phases in the physiology of the organisms, the first stage corresponding to a period of great sugar utilization with less of cell synthesis—a period of high ferment power,—and the second one, a maintenance phase of low ferment power during which vigorous cell synthesis took place.

The products<sup>1</sup> detected and estimated in the fermentation of glucose in Ashby's medium were acetic acid, alcohol, traces of aldehyde, lactic acid, tartaric acid and carbon dioxide. About 21% appeared as carbon dioxide, 14% as cells and 65% as intermediate carbon by-products. The nitrogen content of the bacterial cells increased with age of the culture, and the carbon—nitrogen ratio decreased. The following enzymes were detected in the culture medium:—gelatinase, catalase, deaminase, carboxylase, tyrosinase, urease, oxidase, peroxidase, besides various sugar splitting enzymes.

The above author has also compared the morphology and physiology of nodule organisms isolated from six varieties of groundnuts. The isolates were alike morphologically, but fell into two distinct physiological strains. The characteristics of one group were high gum production, high sensitivity to hydrogen ions, high nitrogen fixation and production of large numbers of small and medium sized nodules. The other group showed the reverse characteristics. The

---

<sup>1</sup> Rajagopalan, T. (1938), *Ind. Jour. Agric. Sci.*, **8**, 3.



presence or absence of bacteriophage has been known to divide up a homogenous strain into two groups as reported in this paper, but this point has not been elucidated.

The life cycle of a selected strain of groundnut nodule organism was also studied by the same author. He confirmed the observation of previous workers that the organism passed through the stages of rods, coccoids, gonidangia, gonidia and microcysts. The formation of banded rod stage was one of the normal processes of development and most commonly met with.

De and Bose<sup>2</sup> studied the changes in the number and activities of different groups of micro-organisms in the soil under conditions similar to those occurring in rice fields in India. The soils were first kept water-logged (water-logging period), then quickly dried and maintained under optimum conditions of temperature and moisture (dry period) and finally kept at high temperature (50-54°C) without adjustment of moisture (desiccating period). The numbers of bacteria and fungi were markedly reduced after the soils were water-logged, particularly at the later stages of water-logging. They again increased in dry period, but the level in all cases except one was lower than that at the start. In the 'desiccating period' there was considerable reduction in both bacterial and fungal numbers. The nitrifying capacity was reduced during the early period of water-logging; it increased at the later period and in dry period, but in the desiccating period the nitrifying power was almost lost. The nitrogen fixing capacity and the number of azotobacter cells decreased during the early period of water-logging, but at later periods increased and remained nearly constant till the end of the desiccating period. Water-logging a soil for a long period was found to have no influence on the activities of ammonifying and nitrifying organisms, when the soil was subsequently dried.

Joshi and Biswas<sup>3</sup> reported a new organism capable of decomposing cellulose, only in presence of some other soil organisms. The organism was present wherever the cellulose was found to be decom-

2 De, P. K. and Bose, N. M. (1938), *Ind. Jour. Agric. Sci.*, **8**, 487.

3 Joshi, N. V. and Biswas, S. C. (1938), *Proc. 25th Ind. Sci. Cong. Calcutta*, Part 3, p. 226.



posing. The organism was isolated by the use of starch agar, where it grew independently of other organisms. The peculiarity of the organism was that it could not decompose the cellulose by itself, but associated with other soil organisms it could decompose cellulose to a considerable extent.

Joshi and Singh<sup>4</sup> studied the mechanism of cyanamide decomposition in three Indian soils with particular reference to the cause of delay that occurred between the accumulation of ammoniacal nitrogen and its conversion into nitrates. The cyanamide decomposed completely within three weeks. Dicyandiamide was formed in one week to three months according to the nature of the soil and was not toxic to nitrifying organisms in the concentration in which it was present in the soils. The delay in the oxidation of ammoniacal nitrogen was most probably connected with that decomposition product of calcium cyanamide which was difficultly soluble in water, but was extractable with 1% hydrochloric acid.

Desai and Fazaluddin<sup>5</sup> studied the process of denitrification in presence of sugars. The reduction of nitrates in solution was found to be accelerated by glucose, the nitrogen being lost as gas. The reduction was not affected by the concentration of the sugar. Further, the nitrates were found to be denitrified readily in presence of sugar. The nature of carbohydrate did not affect the reaction materially. The reduction to ammonia was observed to take place. Most of the nitrogen was lost as gaseous nitrogen. The sugar was oxidised to carbon dioxide, water, acids, and other organic substances. The oxygen of the air was not essential for bringing about denitrification, but played a secondary part in the oxidation of sugar, which was oxidised to a greater extent in presence of air than in its absence. These experiments are likely to explain losses of nitrogen from soils under natural conditions.

Rao, Krishnamurti and Rao<sup>6</sup> studied the microbiological oxidation of ammonia to nitrite with particular reference to the formation

---

4 Joshi, N. V. and Singh, H. D. (1938), *Proc. 25th Ind. Sci. Cong.* Part 3, p. 225.

5 Desai, S. V. and Fazaladdin (1938), *Ind. Jour. Agr. Sci.*, **8**, 447.

6 Rao, W. V. S., Krishnamurthi, P. V. and Rao, G. G. (1938), *Jour. Ind. Chem. Soc.*, **15**, 599.



of intermediate products. They could not detect hydroxylamine and hyponitrite even by very sensitive qualitative tests. The test employed by Corbet has been shown to be non-specific for hyponitrites, but the test was sensitive down to 1 part of nitrite or hydroxylamine or hyponitrite in a million parts of water.

Bal and Krishnamurty<sup>7</sup> confirmed the observation that no nitrification of added ammoniacal or organic nitrogen took place in soils exposed to sunlight even when adequate moisture was present. The process of ammonification remained unaffected. The absence of nitrification was not due to the death of the bacteria, but was due to their temporary inactivity as a result of unfavourable effect of sunlight. In case of soils receiving high doses of nitrogen, a loss of nitrogen to an extent of 3 to 7 per cent. took place during the exposure to sunlight.

Dhar and Mukerji<sup>8</sup> continuing their studies on the effect of light on nitrogen metabolism in soils found that sunlight or artificial light markedly increased nitrogen fixation in soils mixed with energy rich materials like carbohydrates, cellulose, fats etc. They found that the number of azotobacter in soils kept in the dark was ten times greater than that kept in light. Further, the sterile soils also fixed considerable amounts of nitrogen in presence of sunlight. The authors consider that their theory of photo-oxidation is the major process controlling nitrogen metabolism in soils. The negative results obtained by a host of workers who have tried to replicate the work of Dhar and collaborators in this line would however emphasise the need for caution in accepting the conclusions arrived at by the above school of workers.

The same authors<sup>9</sup> reported experiments to explain the process of denitrification taking place in soils and to show how it was retarded by energy-rich substances. Sunlight has been shown to play a very important part in these processes.

---

7 Bal, D. D. and Krishnamurthy, R. S. (1938), *Proc. 25th Ind. Sci. Cong. Calcutta*, Part 3, p. 225.

8 Dhar, N. R. and Mukerji, S. K. (1938), *J. Ind. Chem. Soc.*, **15**, 543.

9 Dhar, N. R. and Mukerji, S. K. (1938), *Ibid.* **15**, 599.



Bhaskaran and Pillai<sup>10</sup> studied the factors that control the large scale conversion of molasses into organic acids. The procedure consisted in mixing molasses with soil and conducting the fermentation in pits under anaerobic conditions. The final product contained 10% of organic carbon. The nitrogen fixed when this product was applied to land (at the rate of 5 tons per acre) corresponded to 2 cwt. of ammonium sulphate.

The same authors<sup>11</sup> studied the dissolution of bonemeal by fermentation with cane molasses and have shown that the percentage dissolution depended upon the particle size of the bonemeal, the concentration of acids formed in the medium and the reversible nature of the reaction.

Sreenivasan<sup>12</sup> studied the industrial production of carbon dioxide from fermentation of cane molasses and worked out an estimate of the production of dry ice showing a profit of 37% on an investment of four lakhs of rupees

---

10 Bhaskaran, J. R. and Pillai, S. C. (1938), *Proc. 25th Ind. Sci., Cong. Calcutta*, Part 3, p. 227.

11 Bhaskaran, J. R. and Pillai, S. C. (1938), *Ibid*, Part 3, p. 227.

12 Sreenivasan, N. (1938), *Curr. Sci.*, **7**, 132.



## VII. PLANT PHYSIOLOGY

By B. N. Singh.

Recent years have witnessed a remarkable progress in Plant Physiology all the world over. The attention of botanists is now being directed more and more towards the various problems connected with the relation between plant structure and plant function. Such an outlook on plant science is bound to result in the long run in rapid strides both in Plant Morphology and Anatomy as well as in Plant Physiology. In the 'year under review, Indian plant physiologists have mainly concerned themselves with problems like vernalisation of seeds, storage of fruits and vegetables, plant nutrition, photoperiodism, the residual effects on soil fertility of leguminous and non-leguminous crops, factors determining distribution of plants, weed control &c. The metabolism of plants has also engaged the attention of workers and it is indeed encouraging to note that greater interest is being taken in the much neglected subject of the physiology of Indian plants.

A brief survey of the researches conducted along different aspects of plant physiology is presented in the following pages.

### 1. Seed and Germination.

Singh, Mathur and Mehta<sup>1</sup> found a fairly high positive correlation between catalase ratios and germination percentages. A catalase ratio greater than unity is associated with seeds of a high degree of viability and low values of the ratio indicate seeds of a poor germination capacity. The greater the value of the catalase ratio the higher is the degree of viability of the seeds. The value of the catalase ratio corresponding to a given germination capacity has also been shown to vary with the crop plant under consideration, for example, a catalase ratio of 2 corresponds to 97% germination in *Cicer* and only 60% germination in *Triticum*.

---

<sup>1</sup> Singh, B. N., Mathur, P. B. and Mehta, M. L. (1938), *Tropical Agric.* **15**, 260.



Hamid,<sup>2</sup> has shown that delinted seeds can easily be stored over their growing season. Delinted seeds retain full vitality during the sowing period which extends over six weeks or so. It has also been shown that delinted seeds stored for one year show slight deterioration.

Mulchandani,<sup>3</sup> studied the effect of soaking in water on germination of cotton seed. Parbhani American (*G. Hirsutum*) cotton seed, having about 13 % fuzz over the seed coat, was soaked for 12, 24, 36, 48, 60, 72, 84, and 96 hours and sown along with dry seeds as control in seven replications at the Government Experimental Farm, Prabhani (Deccan), in typical black cotton soil. The seeds soaked for 12, 24, and 36 hours gave better germination than unsoaked and with further increase in the time of soaking there was corresponding decrease and delay in the germination.

Nandi and Ganguli<sup>4</sup> made a comparative study of the germination capacity of rice seeds under different conditions. The indications are :—(i) that rice grains, though they germinate in water, cannot stand it for further growth ; (ii) that rice seeds germinate well under mud to a depth of 1-2 inches but can hardly make their way out from beyond the depth of 2"; the seeds may remain dormant under a depth of 10" of mud for two years and may germinate again when taken out ; (iii) seeds kept in air tight containers keep their germinating capacity much longer than when kept in open air ; (iv) that the viability of the seeds treated with 2 and 4 % formalin is not affected up to a certain period ; the decrease in the percentage of germination corresponds with the increase in the strength of the solution and period of treatment ; (v) that germination percentage decreases in proportion to the quantity of CS<sub>2</sub> and period of treatment ; (vi) that 15 gms. of seeds are not affected by 5 gms. of naphthalene, while further increase in the quantity naphthalene proves harmful ; (vii) that rice seeds do not germinate in brine, but when taken out and washed they do not show any sign of deterioration till the 21st day, after which the germination percentage

---

2 Hamid, M. A. (1938), Emp. Cotton Grow. Rev., **15**, 312.

3 Mulchandani, B. B. (1939), *Proc. 26th Ind. Sci. Cong.*, Part 3, p. 181.

4 Nandi, H. K. and Ganguli, P. M. (1939), *Ibid*, Part 3, p. 182.



decrease slowly and becomes nil on the 56th day ; (viii) that the highest percentage and quickest germination are obtained by soaking rice seeds for 12 hours ; and (ix) that seeds stored in galvanised iron bins keep up their viability better than those stored in gunny bags.

Luthra and Chima<sup>5</sup> noted that prevalence of hot and dry winds during development retards the growth in size of the grain and causes its desiccation, with the result that it gets shrivelled. They have shown by experiments that germination-power and suitability of shrivelled grains for sowing are not affected by the size of the grain. The progeny plants of shrivelled grains lag behind the plump grains in growth in early stages of development, but the initial differences disappear at a later period. Ultimately, shrivelled grains produce as good a crop as obtained from plump normal grains. The grains of the progeny show an increase of 212.2 per cent. in weight over the parent shrivelled grains. It is shown by the authors that there is no advantage in grading wheat in order to get increased yield in the produce of a pure line.

## 2. Respiration.

Khanna and Raheja<sup>6</sup> studied the respiration of a number of prominent sugarcane varieties *in situ* during an advancing hot weather. It was shown that respiration rate was low in the morning, then rose with the rise in temperature till about 2 P. M. and then rapidly fell. The plant tended to regain its normal function with the return of favourable temperatures in evening. Of the varieties under test, some were observed to be more consistent and less fluctuating in the periodic rate of respiration than the others. Co. 213 was found to be most susceptible, while Co. 313 was least affected. Other varieties ranged themselves between these two extremes in the following ascending order, namely Co. 299, Co. 210 Co. 356, Co. 326, Co. 331 and Co. 214.

The authors have also shown that varieties with higher concentrations of chlorophyll possess narrower range of fluctuations

---

5 Luthra, J. C. and Chima, I. S. (1939), *Proc. 26th Ind. Sci. Cong.*, Part 3, p. 189.

6 Khanna, K. L. and Raheja, P. C. (1938), *Ind. Jour. Agric. Sci.*, 8, 253.



in their respiratory activity as compared to those with lower ones, suggesting that higher concentrations afforded greater stability to the vital processes of the plant. In the beginning of the hot weather the two-hourly fluctuations in the respiratory activity during the day were fairly consistent but as the hot weather advanced, these fluctuations became more pronounced, so much so that in the third series (23rd May to 22nd June) they were the highest recorded. With the passage of time and possibly through adaptation they narrowed down considerably later in the season.

A fair degree of correlation seemed to exist, according to these authors, between the magnitude of depression in the respiration rate and the acknowledged drought resistance of different varieties.

Chatterji<sup>7</sup> has examined the effect of alcohol on respiration. Definite percentages of ethyl alcohol were introduced into the leaves of *Eugenia jambona* and the subsequent acceleration of the respiratory rate has been compared with the amount of alcohol entering the leaves. It was noted that the acceleration of respiratory rate produced by alcohol decreases with time. The percentage of alcohol that brings about the maximum acceleration of the respiratory rate at the beginning does not maintain the increased production of carbon dioxide but subsequently brings about a rapid fall. On the other hand, the alcohol solutions that produce milder stimulation maintain the enhanced respiratory rate for a much longer time.

Samantarai<sup>8</sup> studied the respiration of *Scirpus articulatus* and noted that the respiratory values of the scapes are greater than those of the submerged phase. This difference is ascribed to the low concentration of dissolved oxygen in water.

Saran<sup>9</sup> studied the respiratory behaviour of leaves of *Aralia* sp. subjected for a known period in pure nitrogen and their respiratory ratio ( $\text{CO}_2/\text{O}_2$ ) before and after the nitrogen treatment. It was noted that there is no marked seasonal variation in the initial rate of respiration of the leaves of *Aralia* sp. When nitrogen is substituted for air at or beyond 44 hours of starvation, the rate of respiration

---

7. Chatterji, U. N. (1938), *Proc. Nat. Acad. Sci., India*, **8**, 15.

8. Samantarai, B. (1938), *Jour. Ind. Bot. Soc.*, **17**, 195.

9. Saran, A. B. (1938), *Ibid*, **17**, 287.



gets temporarily enhanced, but the same treatment given at earlier stage (i.e. at 22 hours of starvation) leads to the lowering of the respiration rate. In both the cases, however, when air is again admitted after a course in nitrogen, the rate of respiration is found to shoot up temporarily. After a course in nitrogen the respiratory ratio presents a low value of 0.70 to 0.75 for about a period of 4 hours beyond which it returns to its normal value i.e. unity.

### 3. Pigments.

Singh and Rao<sup>10</sup> developed a new method for the detection of carotenoids in chlorophyll samples. The authors noted that a typical colour curve for chlorophyll in 80 % methyl alcohol exhibits marked absorption in 690  $\mu\mu$  to 610  $\mu\mu$  and less absorption in 500  $\mu\mu$  to 430  $\mu\mu$ . The colour curves of chlorophyll contaminated with carotenoids exhibit higher values in the region 530  $\mu\mu$  to 430  $\mu\mu$ . If carotin is present, the band maximum in the region 530  $\mu\mu$  to 430  $\mu\mu$  is located at 500  $\mu\mu$ , and if xanthophyll is the impurity the band maximum is shifted to 430  $\mu\mu$ . On a comparison of the colour curves of the sample to be tested with the typical colour curves of chlorophyll, the presence of carotenoids at once becomes evident and carotene and xanthophyll are identified separately by the positions of the band maxima in the region 500  $\mu\mu$  to 430  $\mu\mu$ . Carotenoids in as low a concentration as 0.05 % are detected by the new method described.

Makhijani and Banerjee<sup>11</sup> determined the carotene content (carotenoid pigment after separation of chlorophyll and xanthophyll) of seventy-three samples of grasses, hays and other fodders. In the mature green stage, grasses contain 18 to 56 mg. Silage of guinea grass contains only 4 mg., while the grass itself contains 50 mg., Maize, bajri and ragi at the flowering stage contain 24 to 96 mg., but at the straw or fodder stage very little carotene is found. Legumes like kulthi, methi, soyabean, cowpea, peas and karai contain 98 to 182 mg. Lucerne (164 mg.) and paspalam (260 mg.)

---

10 Singh, B. N. and Rao, N. K. A. (1938), *Protoplasma*, **30**, 101.

11 Makhijani, J. K. and Banerjee, B. N. (1938), *Ind. Jour. Vet. Sci. and Anim. Husbandry*, **8**, 13.



are very rich sources of carotene. Dry grasses from forest areas and hays and straws are very poor in this respect.

#### 4. Metabolism.

Singh, Lal, and Prasad<sup>12</sup> have shown that different plant species have different photosynthetic rates, the range of variation from species to species becoming more and more pronounced with advance in the age of plants. Plants economising sugars, proteins, starches and fats in assimilating leaves also store such substances respectively in their storage organs towards the close of their life cycle. The photosynthetic rate seems to be related to the nature of the end product accumulating in assimilating leaves. Leaves accumulating simpler sugars have a fairly high rate of assimilation while those economising the more complex starches, proteins and fats respectively have to their credit decreasing assimilatory efficiency. The biochemical constitution of the experimental material, as judged by the products economised during assimilation, appears to be an important internal factor governing photosynthesis.

Dastur and Mensinkai<sup>13</sup> noted an alternate increase and decrease in the acidity of the sap of roots and stem taking place five times during the season. In the case of leaves after the first increase in acidity, there is a regular decrease in acidity till the last stage when the plant shows signs of drying up. A big fall in the acidity of the sap occurs during the intense flowering period. The authors noted that proteins of the tissues of the plant are on the alkaline side of the isoelectric point during the entire growing period of the plant and that the proteins are positively charged. As the reaction of the sap changes during the growth, the positive charge on the proteins increases or decreases. Thus the number of protein anions and cations changes as the pH value varies and *vice versa*. These variations in the charge of the proteins may be responsible for the

---

12 Singh, B. N., Lal, K. N. and Prasad, K. (1938), *Proc. Ind. Acad. Sci.* **8 B**, 301.

13 Dastur, R. H. and Mensinkai, S. V. (1938), *Jour. Ind. Bot. Soc.*, **17**, 149.



absorption by the plant of the positively and negatively charged ions, as at one time proteins combine more readily with bases than the acids and at other times less readily with bases than with acids.

Dastur, Kanitkar and Rao<sup>14</sup> have studied the carbohydrate content of leaves of various plants exposed to different quantities of light. They also studied the content of water-soluble, organic matter in the leaves of *Helianthus annuus*, *Ricinus communis*, *Abutilon ariaticum*, *Tropaeolum majus*, *Raphanus sativus* and *Nicotiana tabacum*. They found that the order of increase of the water-soluble N of the leaves in different lights of equal total intensity is—carbon arc > daylight lamp > ordinary electric lamp > day light. If monochromatic light and daylight are compared, the organic N content with low light intensity is in the order: daylight > red light > blue violet light. With high intensity, using the carbon arc, the blue violet is more effective than the red. The explanation is put forward that during the process of photosynthetic assimilation there is a condition of balance between protein formation and carbohydrate production. When the ratio of the intensity of red to blue-violet ray is high, as in ordinary electric light, the carbohydrate production is depressed and the formation of proteins is limited by the carbohydrate supply. When the ratio is low, as in daylight, this rate of carbohydrate production and the rate of protein formation are depressed by the accumulation of carbohydrates. With an intermediate condition, as in the light of the carbon arc, both processes go on more actively than in ordinary electric light.

## 5. Nutrition and Elemental Intake.

Singh and Prasad<sup>15</sup>, while studying the effect of chlorine upon the growth and composition of wheat, noted the following facts. The application of chlorine from the very beginning of the life cycle of wheat, brings about a slight depression in dry matter production and an increase in moisture content during the early stages of growth.

---

14 Dastur, R. H., Kanitkar, N. K. and Rao, M. S. (1938), *Annals of Bot.*, **11**, 943.

15 Singh, B. N. and Prasad S. (1938), *Proc. Ind. Acad. Sci.*, **8 B**, 324.



With advance in age, however, the dry matter accumulation is markedly increased without any appreciable increase in water content. Plants supplied with chlorine twenty days after germination have the maximum dry matter yield. Relative growth rate as well as net assimilation rate are also accelerated. Chlorine-treated plants have a larger percentage of ear formation, maximum values being obtained in case where this element is supplied twenty days after germination. The accumulation of carbohydrates, as also the diastatic activity, are greater in the treated plants as compared to the controlled one.

Dastur and John<sup>16</sup> studied the growth of rice seedlings in salt solutions of different H-ion concentrations and found greatest growth in solutions of pH 6.0-7.0. Very little or no increase in dry weight was noticed in salt solutions with low pH values. Acidity lower than pH 6.0 was detrimental to the growth of the seedling. Cultures with ferric phosphate were superior to cultures with  $\text{FeSO}_4$  and cultures without iron. Cultures with potassium nitrate as a source of nitrogen were found superior to cultures with ammonium sulphate. Amongst the single salt solutions, ammonium sulphate and ammonium phosphate are found superior to potassium nitrate. In the other nitrates and ammonium salt solutions the growth of the seedlings was poor. In the two—salt solutions, those combinations which contain ammonium phosphate are found to be superior to other combinations. The ordinary culture solution was found by the authors to be the best of all the solutions used by them.

## 6. Transpiration.

Parija and Samantarai,<sup>17</sup> studied the transpiration of the leaves of deciduous plants such as *Helianthus annuus* and *Datura alba* from the earliest measurable stage to their fall. The transpiration of these leaves, under natural conditions was found to be mostly influenced by changes in humidity. Subsequent work on *Datura* was done under controlled humidity. The transpiratory rate per unit area in

16 Dastur, R. H. and Johan, W. (1938), *Jour. Ind. Bot. Soc.*, **17**, 255.

17 Parija, P. and Samantarai, B. (1939), *Proc. 26th Ind. Sci. Cong.*, part 3, p. 126.



both plants rises with age, then falls to a steady value and ultimately declines. The period of the completion of life cycle, attainment of steady value and the eventual completion of the decline is given.

Mallik<sup>18</sup> described the results of some transpiration measurements with the linseed plant in relation to contemporary meteorological factors. The leaf area, number of stomata, saturation deficit and wind velocity have been recorded. A comparison of transpiration and evaporation under similar conditions has also been made.

Mallik<sup>19</sup> has continued the earlier work of Ramdas and Katti on the exchange of moisture between the surface layer of the soil and the air layers near the ground. The exchange of moisture between plant materials like stalk, leaves and grain and the air layers surrounding them has been studied. It is seen that there is a large diurnal variation in the weights of the specimens examined. The percentage variation on dry basis, is of the order of 12% in the case of soils, 5% in the case of grains, and 17% or more in the case of leaves.

## 7. Water Requirement.

Singh and Mehta<sup>20</sup> have shown, by means of manurial combinations, that a fairly marked relationship existed between water requirement of plants and the degree of fertility of the soil. As yield provides a measure of the fertility of the soil, it is evident from the data presented that there is a correlation between low water requirement and high yield. There is also a correlation between high water expenditure and high degree of fertility. Increasing the fertility of the soil by addition of manures reduces the quantity of water needed for unit dry matter production, but enhances the total quantity of water transpired by the crop.

## 8. Storage of Fruits and Vegetables.

Pal and Pushker<sup>21</sup> have compared the effectiveness of different methods for shortening the rest period of potato tubers. The most

---

18 Mallik, A. K. (1939), *Proc. 26th Ind. Sci. Cong.*, part 3, p. 201.

19 Mallik, A. K. (1939), *Ibid.* p. 201.

20 Singh, B. N. and Mehta, B. K. (1938), *Jour. Amer. Soc. Agron.*, **30**, 395,

21 Pal, B. P. and Pushkar, N. (1938), *Ind. Jour. Agr. Sci.*, **8**, 777.



successful treatment was found to be to peel the tubers and store them in moist saw dust for a week. The response to this method was the quickest and also the most uniform. The ethylene chlorhydrin vapour method and the ethylene chlorhydrin dip method for cut tubers were also distinctly successful, although the results were not quite so good as with peeling. The fourth method tested, viz., the ethylene chlorhydrin dip method for whole tubers proved inferior to all the treatments except the untreated control. It is pointed out that though such methods of breaking the rest period of potato tubers are unlikely to be adopted at present by commercial growers they are of value to potato feeders and geneticists.

The respiration of potato tubers during storage has been investigated in detail by Singh and Mathur.<sup>22</sup> They observed that adolescent, mature and ripe potatoes continue to be distinguished by their respiratory behaviour throughout the period of storage. It was also noted that when potatoes are placed in storage there is a progressive increase in the concentration of internal carbon dioxide until the termination of the period of dormancy, the percentage of this gas falling rapidly with the commencement of sprouting. Data concerning the composition of the atmosphere surrounding the tubers show that, in general, there is an accumulation of carbon dioxide in the surrounding air with increasing periods in storage. It was observed that there is a negative correlation between R. Q. and the percentage of internal carbon dioxide during the stages of dormancy and sprouting. Records concerning the composition of samples of air with-drawn from top, middle and bottom layers of potatoes show a slightly higher percentage of carbon dioxide in the bottom layer than in the middle and top ones. The data obtained concerning the permeability of the periderm of the potato to gas during storage indicate that the permeability of the superficial tissues decreases considerably during the dormancy of tubers.

The same authors<sup>23</sup> have shown that tubers stored for 10-12 days at 18° C. lose considerably less weight during subsequent

---

22 Singh, B. N. and Mathur, P. B. (1938), *Ann. Appl. Biol.*, **25**, 79.

23 Singh, B. N. and Mathur, P. B. (1938), *Ibid*, **25**, 68.



storage than those stored at 70° C. previous to permanent storage. This emphasises the importance of prestoring potatoes for brief duration at a higher temperature preparatory to permanent cold storage. In the adolescent tubers the loss in weight during storage is high and decreases with increasing maturity of the tubers, the value for the total loss being about the same in mature and ripe tubers. Although the magnitude of shrinkage during storage of mature and ripe potatoes is practically the same, the former are superior to the latter in that they keep longer in storage without sprouting. During storage, the loss in weight of potatoes due to respiration is very small in comparison with that caused by evaporation of water.

An attempt was made by Singh and Mathur<sup>24</sup> to test the relation between the developmental stage of potato tubers and the degree of their susceptibility to black heart. The tubers experimented upon belonged to the following stages: adolescence, maturity, ripening, early dormancy, middle dormancy and late dormancy. It was found that, of potatoes of the various developmental stages, those in the middle dormancy stage are most susceptible to blackheart. Data obtained indicated that the smaller tubers are less likely to contract disease than the bigger ones.

Sircar<sup>25</sup> has designed an apparatus to maintain the necessary conditions for allowing the cut discs of potato tubers to respire aerobically for a considerable time in an atmosphere free from carbon dioxide accumulation, and for maintaining salt absorption and water supply to the evaporating cells without interfering with aeration or carbon dioxide measurement during course of experiment. Changes in the nitrogen content of potato tubers as a result of increased metabolic activities have been investigated.

Luthra and Chima<sup>26</sup> describe the results of an investigation made on the metabolism and growth of malta oranges. It is interesting to note that the respiratory activity gradually slows down

---

24 Singh, B. N. and Mathur, P. B. (1938), *Phytopathology*, **28**, 705.

25 Sircar, S. M. (1939), *Proc. 26th Indian Sci. Cong.*, Part 3, p. 125.

26 Luthra, J. C. and Chima, I. S. (1939), *Ibid*, p. 183.



from adolescence to maturity despite the accumulation of carbohydrates. The relative growth rate and nitrogen contents of the developing fruits show strict concomitance with respiratory activity and, statistically, a very high positive correlation has been found to exist between these. Reducing sugars, sucrose and total sugars steadily increase from adolescence to maturity. The reducing sugars are highest just before the climacteric rise in respiration. At no stage of the development of fruits, starch could be noticed either in the flesh or skin of the fruit. The total titratable acids have been found to increase gradually till the 10th day but fall down later on. The total solids are highest in the beginning when the fruit is young but later on decrease, on account of the progressive hydration which follows subsequently.

Singh and Mathur<sup>27</sup> have called attention to the importance of the humidity of the atmosphere as a factor conditioning the loss in weight from potato tubers. The general conclusion arrived at was that high humidities reduce the physiological loss in weight but stimulate sprouting. Evidently, whether a given R. H. is suitable or not will depend upon the duration for which a given lot of tubers is to be preserved. The storage life of the tubers could be divided into three physiological stages, namely, pre-dormancy, dormancy and sprouting. During pre-dormancy there is a rapid loss in weight due to transpiration as well as to respiration. During dormancy, the loss of weight due to both these causes decreases but there is a remarkable increase in weight loss during sprouting.

Singh, Mathur and Mehta<sup>28</sup> have presented data which indicate the presence of cellulase in potato sprouts. This observation is interesting in view of the controversy regarding the function of cellulases in plants. They are believed to be mainly structural materials and suggestions have been made that they act probably as storage materials also. Most of the loss in cellulase was attributable to the loss of xylan—a cellulosan which is associated with most

---

27 Singh, B. N. and Mathur, P. B. (1938), *Proc. 12th Internat. Hort. Cong., Berlin*.

28 Singh, B. N., Mathur, P. B. and Mehta, M. L. (1938), *Current Scie., Dec. 1938*.



celluloses. The authors suggest that xylan, being in all probability less resistant than cellulose, is mainly digested by certain constituents of potato sprouts.

## 9. Irradiation.

Singh and Choudhri<sup>29</sup> found that ten hours of exposure of cotton seed to solar radiation obtained at Benares during the summer does not significantly influence germination. U. V. doses of 5-15 min. duration initiate increased, earlier and more regular germination. Longer exposures are decidedly harmful. Infra-red irradiation causes injury to the seed and retards germination. Longer exposures to I. R. rays of 15 minutes duration and more are so harmful as completely to kill their germinating power. In a combination of U. V. and I. R. the latter possesses a dominating influence. Better germination is only possible when the proportion of I. R. exposure is comparatively low and the seed is at the correct distance. The U. V. treatment may safely be adopted as a rational measure for surface sterilisation of cotton seeds. When the infection is deep, a complete mortality of the parasite is only secured by the combination of U. V. and I. R.

## 10. Vernalisation.

Sen and Chakravarti<sup>30</sup> carried out experiments with mustard (*Brassica juncea* Hooker, type 27) in order to find out whether mustard seeds could be effectively vernalised and this with a view to their possible agricultural use. Seeds in two different stages of germination, viz. (a) seeds just sprouted and (b) seeds with unsplit seed-coats previously soaked in water for twenty-four hours, were subjected to different periods of low temperature. Results so far observed from July to Oct. 1937, in pots and in small garden plots, indicate that (i) Plants from both (a) and (b) types of vernalised seeds show definite earliness in the opening of first flowers as compared to the plants from the control seeds grown under similar conditions. (ii) For the same dose of chilling the degree of vernalisation induced in sprouted seeds is much greater than that induced

---

29 Singh, B. N. and Choudhri, R. S. (1938), *Emp. Cotton Growing Review* **15**, 1.

30 Sen, B. and Chakravarti, S. C. (1938), *Ind. Jour. Agric. Sci.*, **8**, 245.



in unsplit seeds. (iii) Against this one advantage of the sprouted vernalised seeds, unsplit vernalised seeds offer several and those are of more significant nature for purposes of practical agriculture.

## 11. Photoperiodism.

Singh, Kapoor and Choudhri<sup>31</sup> have shown that in durations shorter than 12 hours plants fail to grow normally. Development of chlorophyll and plant parts as also the production of dry matter and grain yields are retarded more and more with the decrease in the duration of illumination. Blossoming and maturation are generally delayed with the exception of plants growing under very short durations which die prematurely. It is also observed that plants behave differently when grown under long durations of illumination. *Crotalaria juncea* thrives best in 12 hours. *Hordeum*, *Gossypium* and *Triticum* in fifteen hours, while *Linum* and *Brassica* need 18 hours daily illumination for best growth. Sexual reproduction takes place only within a certain range of illumination, below which plants tend to become sterile and beyond which giant growth sets in. Plants of more or less similar constitution growing in different seasons of the year also differ markedly in their light requirement, due perhaps to seasonal adaptations.

Singh and Choudhri,<sup>32</sup> while studying the influence of light on shoot elongation and branching in *Crotalaria juncea*, showed that with photoperiods of less than 12 hours both elongation and branching are retarded, because the duration of light is insufficient for optimum growth but that above this period there is a pronounced effect on branching. Further elongation as the photoperiod is increased beyond 12 hours is no doubt related to the suppression of branching. The production of high class fibre would appear to be favoured by long days and it is suggested that latitude and season should be taken into consideration when the cultivation of *Crotalaria* for fibre purposes is projected.

---

31 Singh, B. N., Kapoor, G. P. and Choudhri, R. S. (1938), *Proc. Ind. Acad. Sci.* **7B**, 143.

32 Singh, B. N. and Choudhri, R. S. (1938), *Tropical Agric.* **15**, 202.



Sengupta<sup>33</sup> on the basis of two years work has shown that exposing potatoes to light continually for 25-28 days gives about 50 % more yield although the cost of such a treatment is negligible in comparison to the yield obtained.

## 12. Root Development.

Dhar<sup>34</sup> studied the root development of certain sugarcane varieties under different soil conditions and under different treatments. It has been shown that in sandy soils the individual main roots are bigger in size and at the same time the depth of penetration is maximum and the canes mature earlier than in other soils e.g., clay, clay-loam and sandy-loam. The total number of roots is greater when farm yard manure is applied, but the depth of penetration is less, whereas in the absence of farm yard manure the number of roots is less but the depth of penetration is greater.

## 13. Distribution of Plants.

The distribution of aquatic plants has been studied by Misra<sup>35</sup> with particular regard to the nature of the substratum. It has been shown that the physical and chemical characters of the lake mud are correlated closely with the vegetation on them. There is apparently some close relationship between the quantity of organic matter and plant successions. It has also been shown that although the C/N ratio for submerged plants is low, that of the substratum is high. Decomposition of organic matter in submerged muds has been shown to be mostly anaerobic and large amounts of marsh gas and CO<sub>2</sub> are produced. Oxygen, if available, is rapidly absorbed. Sulphides have been found to be present in appreciable amounts in practically all the submerged muds containing more than 5-10% of organic matter. Nitrates are usually absent from the substratum and nitrogen is available for the aquatic plants in the form of ammonia. Oxidation—reduction potential measurements revealed that the highest reduction intensities are found to exist in soils of moderate organic content.

---

33 Sen-Gupta, D. N. (1938), *Current Sci.*, **7**, 196.

34 Dhar, B. K. L. (1939), *Proc. 26th Ind. Sci. Cong. Lahore*, Part 3, p. 188.

35 Misra, R. D. (1938), *Journ. Ecol.*, **36**, 410.



These are most fertile, contain most available ammonia and the least replaceable hydrogen. The exchangeable bases (with *N.* ammonium chloride) in the muds are related to the organic content of the muds. The author has shown that, in general, a better relation with plant distribution is shown by the bases leaching into water under anaerobic conditions. There is evidence, as the substratum becomes more organic, of increased availability of calcium and nitrogen. The sterility of the most organic soils is attributed to absorption of ferrous iron and to lower available nitrogen.

Mulay and Bhavani,<sup>36</sup> studied the vegetation found round about Laki and Manga Pir—two hot springs in Sind.

Mulay,<sup>37</sup> made some ecological observations on the life history of *Azolla pinnata*, while Stewart,<sup>38</sup> studied the flora of Mussoori.

#### 14. Miscellaneous.

Crowther<sup>39</sup> described the movement of nutrients within the plant following fertiliser applications and against this background discussed the influence of the branching habit of the chief commercial varieties of Indian cotton on the optimum date of application.

Ramji-Narain and Singh<sup>40</sup> have shown that the amount of juice obtained not only depends upon the type of cane crushed but also upon certain other factors such as setting of the mill, speed of the mill, speed of the working bullocks, the amount of feed &c which prevail during crushing. Slow speed was found to give invariably a higher extraction than fast speed, and extra tight setting was better only in the case of thick canes. Of the three levels of feed, 'medium feed' gave the largest amount of juice.

Singh, Chakravarti and Kapoor<sup>41</sup> enumerated the points of contrast between the two parents *Hibiscus esculentus* and *H. ficulneus*

---

36 Mulay, B. N. and Bhavani, G. D. (1939), *Proc. 26th Ind. Sci. Cong.* Part 3, p. 126.

37 Mulay, B. N. (1939), *Ibid*, Part 3, p. 126.

38 Stewart, R. R. (1939), Part 3, p. 126.

39 Crowther, F. (1938), *Ind. Jour. Agric. Sci.*, **8**, 617.

40 Ramji-Narain and Singh, A. (1938), *Ibid*, **8**, 699.

41 Singh, B. N., Chakravarti, S. C. and Kapoor, G. P. (1938), *Jour. Heridity*, **29**, 37.



and the hybrid produced by crossing them. The most striking feature of the  $F_1$  hybrid plants is their hybrid vigour and sterility. After fertilisation, the fruits develop normally and attain their maximum size but fail to produce any seed.

Singh and Mathur<sup>42</sup> studied the respiration, internal gaseous concentration, and percentage chemical composition of sugarcane. It was observed that the rate of respiration is highest in the few apical internodes and decreases in the succeeding ones; the basal portions of the cane stem possess the lowest respiration rate. A significant point is that there is a considerable accumulation of  $CO_2$  in the internal gases accompanied by a corresponding depletion of oxygen. The sucrose content was observed to be very low at the growing point. The reducing sugars and invertase were found highest at the apex. The basal portions contained much acid. They noted that the stage of maturity of a single piece will depend upon the age of the primary shoot or tiller from which it has been cut and the basal portion is more advanced in maturity than the apical portion.

Rao<sup>43</sup> stressed that while the presence of bracts is not advantageous to the plant, as they get mixed, when dried, with seed cotton at the time of harvest, they may on the other hand be useful, functioning as leaves and thus contribute towards nutrition of the fruit. On the above basis new varieties are being developed possessing big bracts which may help towards photosynthesis and at the same time flaring away from the fruit to admit clean picking of cotton.

Gulati and Ahmad<sup>44</sup> studied the effect of environmental and genetical factors on fibre maturity of cotton and described the general effect of sowing period, cultivation, heavy irrigation, fertiliser application, spacing etc., upon the maturity of cotton fibre.

Singh and Sant<sup>45</sup> studied the phenomenon of shedding of buds, flowers and bolls of cotton in relation to environmental and cultural

---

42 Singh, B. N. and Mathur, P. B. (1938), *Proc. Soc., Biol. Chem. India*, **3**, 22-24.

43 Rao, V. N. R. (1939), *Proc. 26th Indian Sci., Cong.*, Part 3, p. 188.

44 Gulati, A. N. and Ahmad, N. (1939), *Ibid*, p. 189.

45 Singh, S. and Sant, G. K. (1939), *Proc. 26th Ind. Sci. Cong. Lahore*, Part 3, p. 190.



factors and have analysed the results to ascertain the correlation between the extent of shedding for the whole or part of the season and the yield.

Ramiah and Varahalu<sup>46</sup> studied the changes in concentration of sap of sugarcane over its entire length from its growing point down to its bottom with the aid of a hand refractometer. They found that the distribution and the mode of accumulation of sugar in the juice during the development of cane towards its maturity, follow a regular sequence which is interesting from the point of view of the physiology of sugarcane. The forms of concentration curves and the character of the changes in form which they undergo are similar in all cases, whether the cane is arrowed or unarrowed, manured or unmanured, or whether it is only in shot blade.

---

<sup>46</sup> Ramiah, P.V. and Varahalu, T. (1939), *Proc. 26th Ind. Sci. Cong.* Part 3.



## VIII. SOILS, FERTILIZERS AND MANURES

*By C. N. Acharya.*

A special feature of the year under review was the amount of attention that was devoted to the study of the physical relationships of the soil, in connection with problems relating to erosion and drainage; dry-farming, soil alkalinity etc. These problems involve the fertility of vast areas of cultivated land spread over different provinces of India. The damage due to some of them, especially soil erosion and alkalinity, is so serious and is getting aggravated at such a rapid rate that unless effective remedies are taken on hand immediately, the damage done may become irreparable. A good amount of valuable laboratory and field investigation has already been carried out in connection with these problems, but much more work remains to be done before they could be effectively solved.

The general lines on which this Review has been written follows those of previous years.

### 1. Soil Survey and Classification.

In view of the importance attached by the Board of Agriculture in India<sup>1</sup> to a genetic system of soil survey and soil classification, the work of Basu and collaborators at Padegaon is timely. They have published during the year<sup>2</sup> the first of their detailed pedological surveys of the Deccan Canal soils, as part of a broader investigation into the question of soil deterioration under perennial irrigation. The first paper limits itself to the Nira Right Bank and the Pravara Canal. The soils are formed from the Deccan trap and belong to the group of Black Cotton Soils. A large number of profiles have been examined for their mechanical and chemical composition. All the normal soils of the tract possess a well developed crumb structure and exhibit 2 to 3 horizons which are differentiated more or less sharply by colour, structure etc.

---

1 Ann. Rpt. for 1937-38, *I. C. A. R., New Delhi*, p. 89.

2 Basu, J. K. (1938), *Ind. Jour. Agri. Sci.*, 8, 637.



Colour seems to be related more to the moisture relationships of the soils rather than to the actual amounts of organic matter present. Black coloured soils are usually found on low lying situations, where the soils remain moist over a considerable part of the year, while soils on higher levels are usually brown.

On account of their high base status and well defined crumb structure, the authors consider these soils to belong to the 'tschernozem' group. The calcareous character of the surface soils, together with zones of accumulation of soluble salts in the deeper profiles, would indicate their being classed as "immature tropical tschernozem."

Raychaudhuri<sup>3</sup> reports the occurrence of red soils in the higher slopes of hills in Chota Nagpur and in Orissa, while brownish soils occur at intermediate layers and greyish black soils lower down. The general morphology of the soil profiles indicate that the red soils of Chota Nagpur belong to the group of red-earth or red-loam, while those of Orissa fall into two categories, viz. (a) vesicular rocky mass, commonly known as "lateritic rock" and (b) nodular gritty mass, commonly known as "lateritic murrum."

## 2. Soil Physics.

The Irrigation Research Institute at Lahore continues to be the main centre of research in this field.

Puri and collaborators are studying in detail the properties of the soil clay—especially of the well leached soil-acidoid. Puri and Dua<sup>4</sup> find that when ethyl acetate or sucrose is treated with soil acidoids, the course of hydrolysis is similar to that due to the action of buffers consisting of true acids. Thus, soil acidoids are shown to be similar in their hydrogen-ion activity to weak acids.

In another paper, Puri and Asghar<sup>5</sup> report that the titration curves of soil acidoids closely resemble those of weak dibasic acids. The point of inflection is noticeable at approximately 4 pH

---

3 Raychaudhuri, S. P. (1939), *Proc. 26th Ind. Sci. Congress, Lahore*, Part, 3, p. 185.

4 Puri, A. N. and Dua, A. N. (1938), *Soil. Sci.*, **46**, 113.

5 Puri, A. N. and Asghar, A. G. (1938), *Ibid*, **46**, 359.



units above the initial pH of the acidoid and corresponds to the neutralization of the first hydrogen. The authors observe that the dissociation constants of soil acidoids could be determined from their titration curves. The pK value is a special characteristic of each soil, measuring the activity of its acidoid fraction. The smaller the pK value, the stronger is the acidoid. Another point of similarity between soil acidoids and true acids lies in their behaviour towards carbonates<sup>6</sup>.

Puri and Sarup<sup>7</sup> have tried to determine the iso-hydric pH value of soils by bringing the soil into contact with buffers of different pH values and noting the buffer which shows no change of pH due to the treatment. A comparison of the isohydric pH values with the ordinary values determined by the quinhydrone and antimony electrode methods, shows great divergency in several cases between the values obtained by the three methods.

It is well known that the pH value of soils, as ordinarily determined, is greatly influenced by the soil-water ratio. Puri and Asghar<sup>8</sup> find this to be due to the depressing effect, on the pH, of salts present in the soil which are brought into solution on the addition of water. The depression in pH varies with the concentration of salts and hence is greater at narrower soil:water ratios. With a view to obtain fairly constant pH values, irrespective of the soil:water ratio, the authors recommend the determination of the pH in presence of *N. KCl*. The procedure gives reproducible values, which however are usually 1.5 to 2 pH units below those obtained in presence of water only, the advantage being that the soil:water ratio does not influence the result. This advantage holds good only for non-calcareous soils, since in presence of carbonate, varying pH values are obtained at different soil: water ratios even in presence of *N. KCl*.

The oxidation-reduction potential of a soil is sometimes attributed to the presence of the ferric-ferrous iron system. Puri and Sarup<sup>9</sup> find

---

6 Puri, A. N. and Puri, M. L. (1938), *Soil Sci.*, **46**, 401.

7 Puri, A. N. and Sarup, A. (1938), *Ibid*, **46**, 49.

8 Puri, A. N. and Asghar, A. G. (1938), *Ibid*, **46**, 323.

9 Puri, A. N. and Sarup, A. (1938), *Ibid*, **46**, 323.



that in normal soils with pH over 5, the above system does not influence the redox potential, since most of the iron is precipitated under the above conditions. They find that for normal soils, the relation between pH and Eh is practically linear and the behaviour of soil acidoids in this respect is similar to that of other acidoids, such as gelatin, humic acid and aluminium or iron silicates, which furnish ionic micellas. In all these cases, a variation of one pH unit corresponded roughly to a change in Eh of 58 millivolts. The authors conclude that the relation between pH and Eh in soils is so perfect that the measurement of pH should suffice for all practical purposes.

Chakraborty<sup>10</sup> has brought out a new modification of his permanganate oxidation method for dispersal of soils for mechanical analysis (*vide Ind. Jour. Agri. Sci.*, **5**, 41) which avoids treatment with 0.2 N. HCl. In this modified method, the organic matter is oxidized by alkaline permanganate, but the precipitated manganese hydroxide is removed by ammonium acetate followed by sodium hydrosulphite. Since ammonium acetate has got a solvent action on calcium carbonate, sodium acetate is substituted in its place for calcareous soils. The results obtained for clay+silt by the above method of dispersion were found to agree with those obtained by the International-A method.

Rao and Samad<sup>11</sup> find that the surface soil at Hagari (Black cotton soil) usually shows a lower hygroscopic capacity than samples taken from lower layers. As the clay content and the  $R_2O_3 / SiO_2$  ratios are more or less uniform in the different layers, the authors attribute the difference in hygroscopic capacity at different layers to the effect of alternate heating and wetting of the surface soil, brought about by weather changes. In support of this explanation the authors adduce experimental evidence to show that alternate heating and wetting of the soil, conducted in the laboratory, causes a decrease in hygroscopic capacity.

The moisture relationships between the air layers near the ground and substances like soils, leaves, seeds etc. have been examined by

---

10 Chakraborty, J. N. (1938), *Ind. Jour. Agri. Sci.*, **8**, 829.

11 Rao, A. S. and Samad, A. A. (1938), *Curr. Sci.*, **7**, 229.



Ramdas and Mallik<sup>12</sup> who find that all these materials show a maximum moisture content at the minimum temperature epoch of the surrounding air (early mornings) and a minimum moisture content at the maximum temperature epoch (2-4 P. M.).

Mitra and Chakravarty<sup>13</sup> report a comparative study of the hydrogen clays obtained from different sub-fractions of the entire clay fraction of a laterite soil from Bengal and a black cotton soil from Akola (C. P.). They find that, with decreasing particle size, the percentage of sesquioxide increases, while that of silica decreases. The smaller the particle size, the greater is the base combining capacity of the hydrogen clay and the greater is the amount of free H-ions associated with a given weight of the material. The ratio of free to total (i. e. titratable) H-ions also increased, though even with the smallest particles the ratio was as low as 0.05, indicating large preponderance of osmotically inactive over osmotically active H-ions in the double layers associated with hydrogen-clay particles.

The results of mechanical analysis of rice soils at Raichur<sup>14</sup> show that, in general, the percentage of clay increases with depth and there is no particular relationship between the clay content and the percentage loss on ignition.

Puri, continuing his previous studies on the electrodialysis of soils, finds, in collaboration with Hoon<sup>15</sup>, that the rate of electrodialysis of different cations is not governed by the state of aggregation of the soil. There is a proportionality between the decrease in conductivity of the soil suspension and the amount of base removed by electro-dialysis. Hence, the authors conclude that differences in the rates of electrodialysis of different cations are due to their different ionic activities—especially in association with insoluble acids such as alumino-silicates.

---

12 Ramdas, L. A. and Mallik, A. K. (1938), *Curr. Sci.*, **6**, 452.

13 Mitra, R. P. and Chakravarty, S. (1939), *Proc. 26th Ind. Sci., Cong.* Part 3, p, 184.

14 Ann. Rpt. for 1937-38, *I. C. A. R., New Delhi*, p. 31.

15 Puri, A. N. and Hoon, R. C., (1938), *Soil Sci.*, **45**, 309.



The marked fall of pH which occurs when CO<sub>2</sub> is bubbled through a soil suspension, is attributed by Puri and Uppal<sup>16</sup> to the increased amount of salts brought into solution thereby, and the authors infer therefore that CO<sub>2</sub> plays a significant role in the reclamation of alkaline soils.

That ammonia retained by soils is in chemical combination with the soil acidoid similar to other bases and that the quantity of ammonia so retained is dependent on the degree of saturation of the soil acidoid and hence on the pH of the soil, are the conclusions arrived at by Puri and Asghar<sup>17</sup> as a result of their experiments, wherein the soil suspension was saturated with ammonia and the free ammonia was removed by boiling the suspension to half its volume.

### 3. Soil Erosion.

The question of soil erosion attracted much attention in India during the year under review and a good amount of data has been collected, thanks mainly to the efforts of Gorrie and other officers of the Forest Department.

Volumetric analysis of water and salt carried out at Madhepur<sup>18</sup> (Punjab) showed that out of a total of 46" which fell on 32 wet days during July-Oct. 1937, the amount of run off was 7% in the case of grassland and 25% in the case of bare soil. The weight of soil lost per acre during the above period was 3,500 lbs. in case of grass cover and 18,500 lbs. in the case of bare soil.

In the dry-farming station at Sholapur<sup>18</sup>, Kanitkar reports losses of about 155 tons of soil per acre per annum from a gently sloping field of jowar, while the soil lost from a cultivated field where the weeds had been preserved in fallow was only 1/200 of the jowar plot and that from a clean fallow of bare but uncultivated ground was about 1/5 of the jowar plot. This shows the aggravative effect of cultivation on erosion losses and stresses

---

16 Puri, A. N. and Uppal, H. L. (1938), *Soil Sci.*, **46**, 467.

17 Puri, A. N. and Asghar, A. G. (1938), *Ibid*, **45**, 477.

18 Gorrie, R. M. (1838), *Indian Forester*, **44**, 327.



the need for bunding even slightly sloping lands under cultivation. The above land had an average slope of 1 in 80.

Gorrie has dealt in detail with the erosion problem in India and other countries of the British Empire in a lecture given before the Royal Society of Arts<sup>19</sup>. In a paper presented before the Punjab Engineering Congress<sup>20</sup>, the same worker deals in detail with the conditions in the Punjab and especially in the Uhl valley which supplies water for the Mandi Hydro-electric Scheme. In this area, nearly 55% of the 21,000 acre farm belt is eroding seriously as a result of potato-farming on untterraced ground and overstocking of the grazing grounds. Gorrie recommends that Government should acquire the worst areas and plan a re-afforestation scheme over an area of 700 acres at a cost of about Rs. 4 lakhs spread over 10 years. As regards the rest of the foot-hill districts, he recommends more active propaganda among villagers to teach them proper methods of conserving their soil by bunding and better methods of farming. The proper shape and situation of stone-bunds to be laid down to stem the storm-waters in hill sides is also discussed by the same author<sup>21</sup>.

The question of soil erosion has also attracted the attention of other workers in India.<sup>22 23 24</sup> Lester-Smith deals with the question in special relation to tea-estates<sup>25</sup>.

#### 4. Dry-farming.

The problems relating to dry-farming are mainly tackled at the chain of research stations established for the purpose by the Imperial Council of Agricultural Research.

In the season 1935-37, when the rainfall was only 60% of normal, the yields of jowar grain and straw obtained at Sholapur<sup>26</sup> by the Bombay Dry-farming Method were more than double those

19 Gorrie, R. M. (1938), *Jour. Roy. Soc. Arts*, **86**, 902.

20 Gorrie, R. M. (1938), *Indian Forester*, **44**, 675.

21 Gorrie, R. M. (1938), *Ibid*, **44**, 149.

22 Smythies, E. A. (1938), *Ibid*, **44**, 704.

23 Sinha, J. N. (1938), *Ibid*, **44**, 329.

24 Sinha, T. (1938), *Poona Agrl. Coll. Mag.* **30**, 7.

25 Lester-Smith, W. C. (1938), *Tea Quarterly*, Ceylon, **11**, 199.

26 Ann. Rpt. for 1937-38, *I. C. A. R.*, New Delhi, p. 47.



obtained by the cultivators' method. The increase was due to the combined effect of bunding, ploughing, and harrowing, low seed-rate and interculturing.

During the same season, the yields at Bijapur centre<sup>26</sup> by the Bombay Dry Farming Method were 100% more in grain and 50% more in straw than by the cultivators' method. In other experiments<sup>26</sup>, highly promising results were obtained by following scoop-ing, sheep-folding and manuring with farm-yard manure.

## 5. Irrigation.

Since the construction of the irrigation canals from the Lloyd Barrage (Sind), fears have been expressed that the water-table may be rising in the canal areas. It has now been found by actual observations<sup>27</sup> that a very large area on the right bank of the Indus (about 3,400 sq. miles) has a high sub-soil water-table, varying from 3 ft. to 13 ft. below the level of the ground. The water-table was nearest the surface at the end of the irrigation (Kharif) season (i. e. in October) and lowest at the commencement of the irrigation season in June. In other areas commanded by the Barrage, notably on the left bank of the river, the sub-soil water table is situated at much lower levels. The problem of probable water-logging is, therefore, considered to be most urgent on the right bank of the river.

## 6. Soil Nitrogen.

Attention still continues to be paid to the question of the chemical and photochemical fixation of nitrogen.

Ramamoorthy<sup>28</sup>, working with Viswa Nath, finds that when air freed from impurities is slowly passed at ordinary temperatures over moist phosphorus and the products of oxidation are absorbed in alkali, appreciable amounts of nitrite are formed. The experiments were repeated with cane sugar at 50°C—98°C and a similar synthesis of oxides of nitrogen was noticed. The synthesis proceeds in the absence of light and in this respect differs from Dhar's photochemical fixation of nitrogen.

---

26 Ann. Rpt. for 1937-38, *I. C. A. R.*, New Delhi, p. 47.

27 Thadani, R. S. K. I. and Mulwani, B. T. (1938), *Curr. Sci.*, **7**, 277.

28 Ramamoorthy, B. (1938), *Proc. National Inst. Sci., India*, **4**, 83.



Rao<sup>29</sup>, in continuation of previous work, finds that appreciable amounts of nitrogen are fixed in the induced oxidation of carbohydrates such as glucose and sucrose in presence of cerium hydroxide, acting as inductor. In a further communication<sup>30</sup>, he reports that even artificial bulb light acts as a photo catalyst and the fixation is optimum in the yellow region ( $0.55-2.0\mu$ ).

On the other hand, Desai and Fazaluddin<sup>31</sup> find that carbohydrates bring about the photo-chemical reduction of nitrates and nitrites, in presence of sunlight and there is simultaneous oxidation of the carbohydrates to acids. Appreciable amounts of nitrogen are lost in the gaseous form, probably due to interaction between nitrite and ammonia that are formed in the process of denitrification. The presence of air is not necessary for the reaction.

Rao and Narayana<sup>32</sup> find that humic acid serves as a catalyst, in the photochemical ammonification of amino-acids such as alanine, aspartic acid and glutamic acid.

In continuation of Dastur's work at Bombay on the differential utilization of ammoniacal and nitrate-nitrogen by the rice plant, Bamji<sup>33</sup> has made a systematic study of the changes in ammoniacal, nitrate and total nitrogen of two rice soils of different grades of fertility. He finds that the natural variations in total nitrogen in the two plots during the year was so much (20 to 25%) that the effect of manuring with 200 lb. of nitrogen in the form of ammonium sulphate or sodium nitrate was hardly perceptible and was completely masked by the major cycle of changes.

The influence of crop residues and of season on soil nitrogen has been examined by Singh *et al*<sup>34</sup> who find that the increase in soil nitrogen due to growing leguminous crops is localised in the stratum of the soil in which the plant feeds. Thus, deep rooted legumes confer on the deeper soil layers a higher available nitrogen content

---

29 Rao, A. L. (1938), *Proc. Soc. Biol. Chem., India*, **3**, 90.

30 Rao, A. L. (1938), *Curr. Sci.*, **7**, 59.

31 Desai, S. V. and Fazaluddin, (1938), *Ind. Jour. Agri. Sci.*, **8**, 447.

32 Rao, G. G. and Narayana, T. S. (1938), *Curr. Sci.*, **7**, 230.

33 Bamji, N. S. (1938), *Ind. Jour. Agri. Sci.*, **8**, 839.

34 Singh, B. N., Singh, S. N. and Gupta, P. P. (1938), *Soil., Sci.*, **45**, 3.



than on the surface soil. The amount of available nitrogen in all cases was low in spring, increased in summer, decreased in the rains and once again rose till the beginning of October. Of the various legumes tried, *Crotalaria juncea* was most effective in increasing soil nitrogen.

## 7. Soil Organic Matter.

Acharya<sup>35</sup> finds that the presence of soil seriously interferes with the estimation of cellulose, due probably to the formation of a ligno-cellulose clay complex which is highly resistant to the usual extraction reagents employed. He has devised a modification of Norman's method of Cellulose estimation, in which the soil is subjected to alternate treatments with acid hypochlorite and alkaline sodium sulphite till a brown colour ceases to be formed on the addition of the latter reagent. The residual carbon content of the soil is determined and a correction is applied for the lignin still present.

Puri and Sarup<sup>36</sup> have followed, potentiometrically, the titration of soil humic acid with different bases and have examined the solubility of the humates formed. While humic acid is readily soluble in 95% alcohol and the Na and K humates are readily soluble in water, Fe and Al humates are insoluble in water or alcohol.

The influence of water-logging and subsequent drying on the micro-organic activities of the soil has been examined by De and Bose<sup>37</sup> with special reference to the rice soil. They find that water-logging reduces bacterial and fungal numbers and the nitrifying capacity of the soil in the earlier stages, but there was a recovery later on. When the soils were dried and raised to 50°C to correspond with the conditions in the summer in Bengal, there was considerable reduction in bacterial and fungal numbers and in nitrifying capacity.

---

35 Acharya, C. N. (1938), *Proc. Soc. Biol. Chem., India*, **3**, 38.

36 Puri, A. N. and Sarup, A. (1938), *Soil. Sci.*, **45**, 165.

37 De, P. K. and Bose, N. M. (1938), *Ind. Jour. Agri. Sci.*, **8**, 487.



## 8. Soils-General.

The influence of soil and climate on the seed composition of crop plants has been examined by Wad and Desai<sup>38</sup>. Analyses were made of average samples of ground-nut, wheat and cotton of the produce of the same variety grown in different places. There were considerable differences in nitrogen content (up to 20%) and oil content (up to 10%) in the same variety. The differences were found to be closely associated with the nutrient composition of the soil layers up to 5 ft. depth.

Now that great insistence is being laid on the proper planning of experiments and statistical analysis of the data obtained, the recent work of Lander and Ramji-Narain<sup>39</sup> on the limitations of soil uniformity trials deserves particular attention. Working with wheat and jowar over an area of 25 acres divided into 15 blocks and each block consisting of 13 experimental plots 207 ft.  $\times$  19 ft., they find that the distribution of fertility between different plots as judged by one crop cannot be taken to be a true index of the behaviour with another crop or even with the same crop in a subsequent season. As such, the application of the principles of co-variance to correct the data of one year with reference to the data obtained in the previous year is of doubtful validity, especially for annual crops. An analysis of the data obtained for some years, by the method of variance, will however, enable us to locate the zone and direction of permanent heterogeneity of the plots and as such to fix the lay out of future experiments more suitably.

Puri and Asghar<sup>40</sup> have devised a simple titrimetric method for the estimation of sulphate in soil extract, by adding  $\text{BaCO}_3$  and titrating the sodium carbonate produced with acid, using thymolphthalein as indicator.

---

38 Wad, Y. D. and Desai, L. N. (1938), *Proc. Soc. Biol. Chem. Ind.*, **3**, 49.

39 Lander, P. E. and Ramji-Narain, (1938), *Ind. Jour. Agri. Sci.*, **8**, 271.

40 Puri, A. N. and Asghar, A. G. (1938), *Soil Sci.*, **45**, 41.



## MANURES

## 1. Composts.

Increasing amount of attention is being devoted to the question of composting town and farm wastes. Acharya<sup>41</sup>, working at Bangalore, finds the hot fermentation process to be specially suitable for the composting of town refuse, such as street sweepings and night-soil. A convenient method of utilization of night soil for manurial purposes is by the preparation of wood-ash-night-soil poudrettes.

Acharya<sup>42</sup> has also worked out a method for the estimation of the furfuraldehyde yield of composts admixed with soil, on lines similar to those proposed by him for soil organic matter (vide Biochem. J., vol. 31, p. 1800). He has also recommended<sup>43</sup> a scheme of analysis for composts admixed with soil, which estimates chemical groups and in this respect is an improvement over the existing empirical methods.

Tambe<sup>44</sup> has dealt with the general question of compost manufacture and considers that the various methods at present in use can be classified into two main groups viz. aerobic and anaerobic, of which the former, especially the techniques worked out at Indore, are quite effective in producing good quality compost.

Wad and Ghosh<sup>45</sup> have examined the possibility of replacing a portion of the concentrated manures used in tea estates by means of composts prepared from prunings and other wastes on the estates. Nitrification studies conducted in the laboratory show that composts, especially bone-meal composts, nitrify as well as the 'general mixture' used in tea estates and that a portion of the latter could be replaced by composts.

The role which composts and natural farm-yard manure play in the nutrition of crops, is still a disputed question, some holding the view that their beneficial effects are mostly mechanical in improving

---

41 Acharya, C. N. (1938), Ann. Rpt, for 1937-38, *I. C. A. R., New Delhi* p, 56.

42 Acharya, C. N. (1938), *Ind. Jour. Agr. Sci.* **8**, 308.

43 Acharya, C. N. (1938), *Proc. Soc. Biol. Chem., India*, **3**, 21.

44 Tambe, G. C. (1938), *Ibid.* **3**, 29.

45 Wad, Y. D. and Ghosh, S. (1938), *Ibid.* **3**, 1.



the physical properties of the soil and others suggesting that the chemical and nutritional properties of compost are as important, if not more, than the physical. Howard has recently contributed an interesting article<sup>46</sup> to the *Empire Cotton Growing Review* wherein he restates in more detail the view he had put forward two years ago in the same journal (vol. 13, p. 186) that the beneficial action of composts is as much nutritional as physical. He states that the application of composts or farmyard manure to the soil yields the healthiest type of plants which are able to resist insect and fungal attacks without the aid of chemical sprays. This health and vigour are attributed to the abundant development of root-mycorrhiza which serve to convey to the plant the required hormones from the decaying organic matter and thus to complete the nutrient factors necessary for healthy growth. He finds that even leguminous plants require the proper development of such mycorrhiza, if they are to mature fully and to set seed. He further advances the view that composts and farmyard manure improve the quality of the crop, as shown by flavour etc. Similar claims have been advanced by several workers both in India and abroad and it would be a good thing if any of the agricultural research institutes in this country, e.g. the one at Delhi, could take up the problem for detailed study in its several aspects, e.g. the development of mycorrhiza in relation to the application of composts or farmyard manure, the part played by mycorrhiza in the nutrition of the crop, influence of composts or farmyard manure in promoting quality, disease resistance, etc.

## 2. Manuring of Rice.

The Imperial Council of Agricultural Research have recently made<sup>47</sup> a statistical study of the available data in India on the manuring of rice and they are carrying out further experiments at a number of stations all over India, in order to verify the conclusions already arrived at.

The trials carried out at Berhampur<sup>48</sup> show that heavy manuring in the nursery alone gave no response, but when the manures were

---

46 Howard, A. (1938), *Empire Cotton Growing Review*, **15**. 215.

47 Ann. Rpt. for 1937-38, *I. C. A. R., New Delhi*, p. 49.

48 *Ibid*, p. 25.



applied to the transplant field there was increased yield, irrespective of manuring the nursery. Similar results have been obtained at Sabour.<sup>49</sup>

The application of ammonium sulphate (25 lb. N per acre, alone has not been found to be remunerative at Berhampur<sup>48</sup>, but when accompanied by 2,000 lb. of green leaf, a net profit of Rs. 4 per acre was obtained. Similarly, superphosphate (25 lb.  $P_2O_5$  per acre) alone has not shown any response, but along with 4000 lb. of green leaf, a net profit of Rs. 4/8/- per acre was obtained. The soils at Berhampur are known to be deficient in organic matter and they respond to applications of even small amounts of green matter alone.

The experience at Sabour<sup>49</sup> has been similar to that at Berhampur, in as much as a combination of green manure and phosphates has given the highest yield. The experience at Raichur<sup>50</sup> has however been otherwise in that super phosphate (at 20 lb.  $P_2O_5$  per acre) by itself is a paying proposition and gives the largest net profit of Rs. 4/- per acre. The addition of ammonium sulphate along with super, has not shown any increased profit.

As regards the time of application of manure, the indications at Sabour are that application of artificials two weeks after transplanting gives a better yield than the present practice of applying them at the time of transplanting; but the experiments require confirmation.

Application of lime has not been beneficial to rice at Berhampur.<sup>48</sup>

De,<sup>51</sup> working in Fritsch's laboratory in London, has isolated certain algae which are associated with the water-logged conditions of the rice soil and has shown that the algae exert a definite fertilizing action on the growth of the rice crop. This work is of special interest since it serves to explain the previous

---

49 Ann. Rpt. for 1937-38, I. C. A. R., New Delhi, p. 30.

50 Ibid, p. 31.

51 De, P. K. (1938), *Chemical Agri.* **39**, 282.



observations of Harrison and Iyer at Coimbatore<sup>52</sup> regarding the beneficial role of algae in the nutrition of the rice crop-

### 3. Manuring of Sugar-Cane.

Now that the initial boom of the Indian Sugar trade is coming to an end and there is increasing internal and external competition, more attention is being paid to the better nutrition of the sugarcane crop, so as to obtain the maximum yield per acre.

Sayer<sup>53</sup> has summarised the results obtained at Pusa in this connection, which go to show that ammonium sulphate and sodium nitrate are about equally efficient as manures for sugarcane. Application of nitrogenous fertilizers in two doses was more conducive to tonnage yield than the single dose. Further, manuring just before the break of the monsoon was more helpful to sugarcane than at other times in the year.

Pal<sup>54</sup> finds that in the acid soil of the Jorhat farm (Assam), P. O. J. 2714 responds to 200 lb. of alphas, by showing an increase of 1.06 tons per acre of stripped cane in the first year and 1.6 tons in the second year. But as regards the quality of the juice, "no alphas" gave a better juice than the phosphate application.

The work carried out at Shahajanpur<sup>55</sup> by the Imperial Council of Agricultural Research has shown that nitrogen up to 200 lb. per acre increases cane yields. Potash and phosphates do not show any appreciable response. Molasses, to the extent of 270 maunds per care, showed appreciable increase, but green manuring with *sanai* (50 days growth) was the best.

The manurial experiments carried out at Risalewala<sup>55</sup> (Punjab) by the same agency, showed that a combination of toria cake or ammonium sulphate with farmyard manure to make up 140 lb. of N per acre gave better and more economical returns than if the

---

52 Harrison, W. H. and Iyer, P. A. (1914—20), *Mem. Dept. Agri. India, Chemical Series*, **3**, 65; **4**, 155; **5**, 1, 173, 181.

53 Sayer, W. (1938), *Agri. & Livestock in India*, **8**, 165.

54 Pal, H. N. (1939), *Proc. 26th Ind. Sci. Cong.*, Part 3, p. 186.

55 Ann. Rpt. for 1937-38, *I. C. A. R., New Delhi*, p. 70.



same dose of nitrogen was applied as farmyard manure alone. 175 lb. of nitrogen per acre (70 lb. of nitrogen as farmyard manure and 105 lb. of nitrogen as ammonium sulphate) gave the highest net profit, viz. Rs. 54/4/- per acre.

#### 4. Manuring of tea.

The controversy regarding the usefulness or otherwise of composting tea estate wastes, such as prunings etc., before applying them to land seems to have decided itself in favour of the direct application of the material to land without prior composting<sup>57</sup>. This is in consonance with scientific expectation, since tea estate wastes generally have a narrow C:N- ratio (about 12:1) and could with advantage be directly put on the land.

Carpenter<sup>58</sup> has given an excellent review of the application of science to modern tea culture. The experience at Tocklai has shown that tea responds to nitrogen, especially as ammonium sulphate. Since, in the usual practice of tea estates the prunings, which amount to 5 to 6 tons of green material of good nitrogen content, are returned every year to the soil, further addition of bulky manures such as farmyard manure or green manure or composts, do not show as good response as inorganic nitrogenous fertilizers. 1 lb. of nitrogen applied as ammonium sulphate gives on the average an increase of 5 to 6 lb. of tea. Since tea prefers an acid soil (pH 4.5 to 5.5), applications of ammonium sulphate are specially suitable. Potash and phosphoric acid have not shown any response at Tocklai; on the other hand, potash had a slight adverse effect on quality.

Norris<sup>59</sup>, in reviewing Carpenter's conclusions, finds that the experience in Ceylon agrees with that at Tocklai so far as the response to nitrogen is concerned. As regards potash, the Ceylon experience has been that the omission of it has been detrimental. The difference is probably due to the higher content of available

56 Ann. Rpt., I. C. A. R., New Delhi, p. 71.

57 Eden, T. (1938), *Tea Quarterly, Ceylon*, **11**, 194, *vide also Bull No. 16 of Tea Research Institute, Ceylon*, p. 18.

58 Carpenter, P. H. (1938), *Empire Jour. Exptl. Agr.*, **6**, 1.

59 Norris, R. V. (1938), *Tea Quarterly, Ceylon*, **11**, 3.



potash in the Assam soils. Carpenter has stated that the Assam leaf normally contains much more potash than the Ceylon leaf.

Eden<sup>60</sup> has discussed in detail the problem of the manuring of tea with special reference to Ceylon conditions. The manuring of the crop 6 months after pruning has given better results than manuring at the pruning stage. An economical and efficient manurial mixture would consist of castor-cake 20 lb., ammonium sulphate 130 lb.; muriate of potash 30 lb.; and Saphos or safaga 70 lb. 165 lb. of this mixture may be applied at 6 months after pruning and 235 lb. at 15 months after pruning, making a total application of 400 lb. per acre.

## 5. Manures—General.

Pot experiments with wheat (Singh<sup>61</sup>) showed that increasing the fertility of the soil by addition of manures, reduced the quantity of water needed per unit of dry matter produced; but the total water transpired increased with the total yield and hence was greater at higher fertility levels. Similar results have been obtained at Sholapur and at Rohtak<sup>62</sup> with Jowar and Bajra.

The application of fertilizers to crops as a means of controlling weeds has been tried by Singh and Das<sup>63</sup> who find that treatment with a mixture of ammonium sulphate, super phosphate and potassium sulphate decreased *C. album* by 33.73 % and *A. arvensis* by 42.76 %.

Dabral and Chiney<sup>64</sup> find that in field trials with cotton, using plots 1/40 acre, the inclusion of borders in the yield data, caused a disturbance in the mean value of the treatments, so that the significance of the best treatments was lost.

Bhaskaran *et al*<sup>65</sup> have investigated the possibility of using fermented molasses for the dissolution of bone and find that about

---

60 Eden, T. (1938), *Tea Quarterly*, Ceylon, **11**, 187.

61 Singh, B. N. and Meta B. K. (1938), *Jour. Amer. Soc. Agron.* **30**, 37.

62 Ann. Rpt for 1937-38, *I. C. A. R., New Delhi*, pp. 47 and 49.

63 Singh, B. N. and Das, K. (1938), *Jour. Amer. Soc. Agron.* **30**, 465.

64 Dabral, B. M. and Chiney, S. S. (1938), *Indian Jour. Agr. Sci.* **8**, 629.

65 Bhaskaran, T. R., Pillai, S. C. and Subrahmanyam, V. (1938), *Jour. Indian Inst. Sci.* **21 A**, Part. 4, p. 27



20-25 % of the phosphate present in bone could be brought into solution in about 10 to 15 days. The authors consider that though the method may not be useful for the preparation of soluble phosphate, molasses could be utilized by mixing it with bone or other phosphatic materials for direct application to land.

The manufacture of synthetic nitrogenous fertilizers, such as ammonium sulphate and mixed nitrate fertilizers, is attracting increasing attention in India (Acharya<sup>66</sup> Chatterji<sup>67</sup>).

---

66 Acharya, C. N. (1938), *Madras Agr. Jour.* **26**, 285, 382, 414.

67 Chatterji, N. G. (1938). *Science & Culture*, **4**, 178.



## IX. CHEMISTRY OF PLANT PRODUCTS

By S. Dutt.

Chemical investigation of plant products is one of the most fruitful though somewhat difficult form of research and one that has got tremendous scope and possibilities in India when organised on proper lines. On account of the climate and geographical situation, India possesses endless varieties of flora, many of which contain active principles of great physiological or technical importance. Unfortunately in India, the trend of organic chemical research at present seems to be more confined to synthetic lines with production of new compounds of doubtful utility than to the study of plant products, in spite of the great opportunities offered by the latter for investigation and for the exercise of ingenuity and experimental skill. India being essentially an agricultural country, there is hardly any doubt that any future industrial development of India will be intimately connected with the study and proper utilisation of her plant products.

Chemical investigation of plant products by Indian workers, during the year 1938, may be classified under the following heads :

(1) Essential oils, (2) Fixed oils, (3) Sterols and lactones, (4) Glucosides, (5) Plant colouring matters and (6) Miscellaneous.

### 1. Essential Oils.

Dutt<sup>1</sup> has isolated the essential oil of *Ocimum sanctum* Linn, or *Tulsi* in the form of a pale yellow oil in any yield of 0.7 per cent, by steam distillation of the leaves of the plant. Further examination of the oil resolved it into phenolic and non-phenolic constituents by aqueous sodium hydroxide, and from the phenolic portion, carvacrol and eugenol were definitely isolated and identified. From the non-phenolic portion, eugenol methyl ether was definitely identified and the presence of caryophyllene was tentatively shown. The essential oil was found to contain over 70 per cent of eugenol and 20 per

---

1 Dutt, S. (1939), *Proc. Ind. Acad. Sci.*, **9A** 72.



cent of eugenol methyl ether together with about 3 per cent of carvacrol. It is undoubtedly an excellent source of eugenol for the manufacture of vanillin.

Tayal and Dutt<sup>2</sup> have isolated the essential oil of *Ocimum Canum Sims.*, in the form of a pleasant smelling pale yellow oil in an yield of 0.6 per cent by steam distillation of the leaves and stems of the plant, which grows abundantly and wild on the river banks and marshy places or low lands in the United Provinces, during the rainy season and immediately after. The oil on further examination was found to consist of the following constituents: (1) linalool, 10.9 %, (2) geraniol and citronellol, 7.3 %, (3) esters, mainly geranyl, and citronellyl—acetate, 4.8 %, (4) methyl-heptenone, 2.4 %, (5) citral, 60.0 %, (6) citronellal 7.3 %, (7) unidentified aldehyde, 4.8 % and (8) unidentified terpene hydrocarbon, 2.4 %. The oil when manufactured on a large scale will be an excellent source of commercial citral.

Dutta Ghosh and Chopra<sup>3</sup> report that the roots of *Hemidesmus indicus Linn.*, contain 0.225 per cent of an essential oil, 80 per cent of which consists of 4-methoxy-salicyl-aldehyde, which gives the characteristic odour to the plant product. The oxime and the semi-carbazone prepared in the usual manner melted at 141°C and 224°C respectively.

Chopra and Ghosh<sup>4</sup> have found that the leaves of *Erythroxylon monogynus Roxb.*, contain an essential oil responsible for the tonic properties of the plant.

Deshapande<sup>4a</sup> has isolated the essential oil from the flowers of *Pandanus odoratissimus* (Kewda) in an yield of about 0.06 per cent, by steam distillation. On further fractionation, under diminished pressure the oil was resolved into a main fraction boiling at 180–185°C at 710 mm., or at 70–74°C at 12 mm, consisting of the methyl ether of phenylethyl alcohol, and this was definitely identified by a direct comparison with the synthetic specimen prepared by

2 Tayal, J. N. and Dutt, S. (1938), *Proc. Nat. Acad. Sci.*, **8**, 120.

3 Dutta, A. T., Ghosh, S. and Chopra, R. N. (1938), *Arch. Pharm.*, **276**, 333.

4 Chopra, R. N. and Ghosh, N. N. (1938), *Ibid*, **276**, 340.

4a Deshapande, S. S. (1938), *J. Ind. Chem. Soc.*, **15**, 509.



the methylation of phenylethyl with methyl iodide in presence of silver oxide.

## 2. Fixed oils.

Rao, Rao and Seshadri<sup>5</sup> have isolated from the seed of *Erythrina indica* Linn, growing in the Waltair district, 11.3 per cent of a fixed oil having the following properties: Sp. Gr., at 30°C = 0.8821; refractive index at 30°C = 1.4596; acid value = 1.24; saponification value = 184—185; iodine value = 63.3; titre = 20—21°C; unsaponifiable matter = 0.81 per cent. Except for the lower iodine value, the oil is similar to that extracted from the Formosan variety.

Gupta and Lal<sup>6</sup> in the course of an examination of the seed of *Physalis peruviana*, have isolated a pale yellow semi-drying oil in an yield of 6.2 per cent, with following properties:  $[a]_D^{20} = -0.38^\circ$  in chloroform; acid value = 39.06; saponification value = 179.6; acetyl value = 41.56; Hehner value = 93.4; iodine value = 120.5; unsaponifiable matter, (containing a phytosterol  $C_{28}H_{44}O_3$ , m.p., 131°C) = 0.4 per cent. The fatty acids comprise, oleic = 42.4; linoleic = 37.5; palmitic = 6.6 and stearic = 5.5 per cent of the oil respectively.

Pendse<sup>7</sup> has obtained from the seeds of *Plantago ovata* Forsk, an oil in which the saturated acids consist of palmitic acid = 3.7; stearic acid = 6.9 and lignoceric acid = 0.8 per cent of the oil respectively.

Madhuranath and Manjunath<sup>8</sup> have isolated from the seeds of *Santalum album* Linn., an oil with the following characteristics: Sp. Gr. at 25°C = 0.9356; refractive index at 25°C = 1.4891; saponification value = 176; iodine value = 153; thiocyanogen value = 151; acid value = 29 (extracted oil) or 44 (expressed oil)

---

5 Rao, P. S., Rao, C. V. and Seshadri, T. R. (1938), *Proc. Ind. Acad. Sci.*, **7A**, 179.

6 Gupta, M. P. and Lal, J. B. (1938), *Proc. Nat. Acad. Sci.*, **7**, 131.

7 Pendse, G. P. (1938), *Ibid*, **7**, 137.

8 Madhuranath, M. K. and Manjunath, B. L. (1938), *J. Ind. Chem. Soc.*, **15**, 389.



R. M. value = 0.9 ; acetyl value = 22 - 25 ; diene value = 3.9. The oil yields 8.8 - 13 per cent of unsaponifiable matter (including a phytosterol, m. p. 131°C, acetate, m. p. 118°C), 49 per cent of liquid fatty acids (containing mainly oleic with a small amount of linolenic acids) and 51 per cent of solid fatty acids and (comprising mainly santalbic acid with a small amount of palmitic acids). Santalbic acid,  $C_{18}H_{30}O_2$ , m. p. 41 - 42°C (p-phenyl-phenacyl ester, m. p. 56 - 57°C) absorbs six atoms of hydrogen on catalytic hydrogenation with formation of stearic acid, but gives oils with bromine or maleic anhydride and does not undergo photo-polymerisation.

### 3. Sterols and lactones.

Dutta, Ghosh and Chopra<sup>9</sup> have isolated from the roots of *Hemidesmus indicus*, two sterols, namely, hemidosterol  $C_{34}H_{40}O$ , m. p. 182.4°C,  $[a]_D^{30} = +83^\circ$  in chloroform (acetyl derivative, m. p. 198°C, benzoyl derivative m. p. 188.5°C) and hemidesmol,  $C_{33}H_{58}O$ , m. p. 161°C,  $[a]_D^{30} = +57^\circ$  in chloroform (acetyl derivative, m. p. 188°C, benzoyl derivative, m. p. 222.5°C) in addition to sugars, resins, tannins and a small amount of a glucoside, m. p. 133 - 136°C (decomp.)

Wallis and Chakravarty<sup>10</sup> while working on sterols from cotton seed oil, found that the crude sterol when fractionally crystallised from benzene-alcohol mixture, yielded  $\beta$ -sitosterol, m. p. 136 - 137°C,  $[a]_D^{25} = -36.6^\circ$ .  $\alpha$ ,  $\alpha'$  or  $\gamma$ -sitosterol could not be detected. The residue contained an unidentified wax, while the saturated sterols included stigmasterol (less than 1 per cent). The following derivatives of  $\beta$ -sitosterol were prepared: acetate, m. p. 146 - 147°C,  $[a]_D^{25} = -13.8^\circ$ ; m-dinitrobenzoate, m. p. 202 - 203°,  $[a]_D^{25} = -10.4^\circ$ . All the rotations were taken in chloroform solution.

9 Dutta, A. T., Ghosh, S. and Chopra, R. N. (1938), *Arch. Pharm.* **276**, 333.

10 Wallis, E. S. and Chakravarty, P. N. (1938). *British Chem. Abs.*, **III**, 359.



Pendse and Lal<sup>11</sup> who previously obtained a sterol from the seeds of *Blepharis edulis* and ascribed a formula  $C_{27}H_{47}O$ ,  $2H_2O$  to it, have now revised the formula to  $C_{27}H_{42}O_3$ .

Lal<sup>12</sup> has obtained from the seeds of *Physalis peruviana*, a sterol  $C_{27}H_{44}O$ ,  $H_2O$ , melting at  $132^\circ C$ .

Gupta and Dutt<sup>13</sup> in course of their investigations on *Indigofera linifolia* Retz, isolated from it a wax identified as ceryl palmitate and a lactone  $C_{26}H_{50}O_2$ , m.p.  $96^\circ C$ , which they named "linifolin."

Gupta and Dutt<sup>14</sup> obtained from the seeds of *Solanum xanthocarpum* (Schard and Wendle) in addition to other substances, a 1 : 2—unsaturated lactone named "solanacarpone",  $C_{28}H_{42}O_7$ , m.p.  $78^\circ C$ , and also a sterol named "carpesterol", m. p.  $168^\circ C$ ,  $[\alpha]_D^{20} = -80^\circ$ , benzoyl derivative m. p.  $216^\circ C$ .

Rao, Rao and Seshadri<sup>15</sup> obtained from the seeds of *Psoralea Cordifolia*, two lactones, psoralen (I) and iso-psoralen (II). With caustic soda and mercuric oxide, these give trans-psoralic acid, m. p.  $220^\circ C$  (decomp.) and iso-psoralic acid, m. p.  $173-175^\circ C$  (decomp.) respectively, identified by conversion into known methyl esters. The acids are mainly resinified by concentrated sulphuric acid, but are converted by hot aqueous mercuric chloride or by light in alcoholic solution into (I) and (II) respectively, the yield of (II) being slightly greater than that of (I) owing to the difference in the case of isomerism to cis acids or of ring closure.

Chopra and Ghosh<sup>16</sup> while working on the Indian variety of aloes, namely *Aloes vera* and *Aloes-indica*, isolated coumarin from them along with chrysophanic acid and emodin (?).

Spath, Dey and Tyray<sup>17</sup> have done further work on the constitution of toddalolactone. They have converted it by the action of tetracetyl lead in benzene solution into acetone and an aldehyde  $C_{13}H_{12}O_5$ .

11 Pendse, G. P. and Lal, J. B. (1938), *J. Ind. Chem. Soc.*, **15**, 471.

12 Lal, J. R. (1938), *Proc. Nat. Acad. Sci.*, **7**, 59. (J. B.)

13 Gupta, M. P. and Dutt, S. (1938), *Ibid*, **7**, 49.

14 Gupta, M. P. and Dutt, S. (1938), *J. Ind. Chem. Soc.*, **15**, 95.

15 Rao, P. S., Rao, C. V. and Seshadri, T. R. (1937), *Proc. Ind. Acad. Sci.*, **6A**, 148, 254.

16 Chopra R. N. and Ghosh, N. N. (1938), *Arch. Pharm*, **276**, 348.

17 Spath, E., Dey B. B. and Tyray, E. (1938), *Ber.* **71**, 1825.



MeOH, m.p. 142—142.5° C. The side chain therefore consists of  $\text{OH}\cdot\text{C}(\text{CH}_3)_2\cdot\text{CH}-(\text{OH})-\text{CH}_2-$ grouping. By the action of methyl sulphate and caustic soda, the substance is converted into a methoxylated cinnamic acid, degraded by oxidation into 2:4:6-trimethoxybenzene-1:3-dicarboxylic acid. From these and other evidences, toddalolactone is supposed to be a 5:7-dimethoxy-coumarin with a side-chain in 6 position.

Chakravarty and Wallis<sup>18</sup> have found that Fieser and Neumann's formula (Abs. 1936, 1116) for trianhydrolactone from onabain is untenable, since the acetate with chromic acid gives no ketone, and nitric acid gives no aromatic acid. Epi-neoergosterol has m.p. 175-176°C and its acetate has m.p. 98°C. With chromic acid at 60-65°C, it gives a ketone  $\text{C}_{18}\text{H}_{20}\text{O}$ , m.p. 114-115°C (semicarbazone, m.p. 255°C with decomposition), the absorption of which resembles that of neo-ergopentaene (Cf. Marker, Abs. 1936, II, 1256; Windhaus, Abs., 1937, II, 99).

#### 4. Glucosides.

Bose and Mukherjee<sup>19</sup> have worked up the glucosides contained in the flowers of *Murrya exotica* which were originally isolated by de Vry and Blas (Z. Chem. 1869, 310), and found that they consisted of scopolin 1.3%) hydrolysed to scopoletin (aesculin methyl ether) by dilute acids. Murrayin and murrayatin isolated by the previous authors were shown to be impure scopolin and scopoletin respectively.

Dutt, Chatterjee, Ghosh and Chopra<sup>20</sup> isolated from the roots of *Pavis polyphylla*, an amorphous glucoside, m. p. 162—163°C, having marked physiological properties, together with a crystalline substance melting at 238—240°C.

Lahiri, Ghosh and Chopra<sup>21</sup> have devised a method of preparing pure thevatin from the seeds of *Thevatia nerifolia* in a better yield

18 Chakravarty, P. N, and Wallis, E. S. (1938), *J. Amer. Chem. Soc.* **60**, 1379.

19 Bose, P. K. and Mukherjee, A. (1937), *J. Ind. Chem. Soc.*, **14**, 489.

20 Dutt, A. T. Chatterjee, N. R. Ghosh, S. and Chopra, R. N. (1938), *Arch., Pharm.* **276**, 343.

21 Lahiri, J. K., Ghosh, S. and Chopra R. N. (1938), *Arch. Pharm.* **276**, 345,



than the previous authors. The thevatin obtained in this way sinters at 192°C and has a laevo rotation of 62.5° in methyl alcohol at 26°C. The yield obtained is 0.56 per cent.

## 5. Alkaloids.

Damodaran and Ramaswami<sup>22</sup> have isolated from the seeds of *Mucuna puricus*, by the employment of Guggenheim's<sup>23</sup> method, *l*-3:4-dihydroxy-phenyl-alanine (picrolonate, m.p. 241°C with decomposition) and hydantoin. The latter is obtained in an yield of 1.5 per cent. The authors further state that the hydantoin does not interfere with the determination of ascorbic acid present in the seeds by the 2:6-dichlorophenol indophenol method, but is likely to do so in the determination of thiol compounds by the phosphotungstic acid reagent.

Gupta and Dutt<sup>24</sup> have obtained from the defatted seeds of *Solanum xanthocarpum* by extraction with alcohol, the gluco-alkaloid solanacarpine, to which the new formula  $C_{44}H_{74}O_{11}N_2$  has been ascribed. The pure substance was found to melt at 272°C and to have a dextro-rotation of 83.5° in chloroform at 20°C. In the extraction and purification of the alkaloid, it has been found that the leadsalt-hydrogen sulphide method causes extensive hydrolysis, and so the chromate-ammonia method has been used with success. The chromate of the alkaloid is hydrolysed with 5 per cent hydrochloric acid to solanacarpigenin,  $C_{32}H_{54}O_2N_2$  (m.p. 196°C;  $[\alpha]_D^{20} = +88.79^\circ$ ) and rhamnose.

## 6. Plant Colouring Matters.

Bose and Bhattacharya<sup>25</sup> have isolated from the bark of *Oroxylum indicum* Vent by extraction with alcohol, baicalein (cf. Shibata<sup>26</sup>) in the form of the lead salt, from which pure baicalein was ultimately obtained. The bark also yielded a mixture of substances which on demethylation gave baicalein and chrysin.

22 Damodaran, M. and Ramaswami, R. (1937), *Biochem. J.*, **31**, 4149.

23 Guggenheim, T. (1914), *Abs.*, i, **49**.

24 Gupta, M. P. and Dutt, S. (1938), *J. Ind. Chem. Soc.*, **15**, 95.

25 Bose, P. K. and Bhattacharya, S. N. (1938), *Ibid.*, **15**, 389.

26 Shibata, P. (1923) *Abs.* i, **59**.



Narang, Ray and Ray<sup>27</sup> gave the new formula  $C_{27}H_{26}O_7$  to rottlerin in contradiction to their previous formula  $C_{31}H_{30}O_8$ . They found that on methylation with methyl sulphate in acetone solution in presence of potassium carbonate and bicarbonate rottlerin gave a tetramethyl ether, m. p.  $144^\circ C$ , which yielded no acetyl derivative. On oxidation with hydrogen peroxide in alkaline solution, it gave a substance  $C_{31}H_{36}O_8$ , m. p.  $128^\circ C$  with decomposition, which was converted by catalytic hydrogenation into tetrahydro-rottlerin-tetramethyl ether, m.p.  $108^\circ C$ , also obtained by methylation of tetrahydro-rottlerin.

The same authors<sup>28</sup> have again changed their formula for rottlerin later on to  $C_{31}H_{30}O_8$ , and have criticised the views of Robertson and others in this connection. Brockmann and Maiver<sup>29</sup> have however found the formula of rottlerin to be  $C_{30}H_{28}O_8$ . According to them, rottlerin contains four active hydrogen atoms, and when treated with ozone or potassium permanganate, gives 0.2 molecules of acetone, indicating the presence of isopropyl or gem-dimethyl groups. With acetic anhydride rottlerin gives a penta-acetyl derivative and with diazomethane, it gives a dimethyl ether, m.p.  $245-246^\circ C$  (decomp.), which on further methylation gets converted into a pentamethyl ether,  $C_{30}H_{23}O_8 (OMe)_5$ , m.p.  $142.5^\circ C$ , which is identical with the so called tetramethyl-rottlerin of Ray and his colleagues, and to which they have given the formula  $C_{27}H_{22}O_8 (OMe)_4$ .

According to Brockmann and Maiver, hydrogenation of rottlerin (colloidal palladium in acetone) affords tetrahydro-rottlerin  $C_{30}H_{32}O_8$ , m.p.  $211^\circ C$ , (penta-acetate, m.p.  $188^\circ C$ ). Similarly rottlerin diemethyl ether affords tetrahydro-rottlerin dimethyl ether, m.p.  $193-194^\circ C$ , also obtained by the methylation of tetrahydro-rottlerin. This is converted by methyl sulphate and potassium carbonate in boiling acetone into tetrahydro-rottlerin pentamethyl ether, m.p.  $108-108.5^\circ C$ . Treatment of rottlerin with hydrogen

27 Narang, K. S., Ray, J. N. and Ray, B. S. (1937), *J. Chem. Soc.* **151**, 1862.

28 Current Science, (1938), **6**, 606.

29 Brockmann, H. and Maiver, K. (1938), *Annalen*, **535**, 149.



peroxide in alkaline solution gives cinnamic acid, while benzaldehyde is obtained by degradation with ozone or when rottlerin is boiled with dilute caustic soda, thus disclosing the presence of  $C_6H_5CH:CH$ -group. The formation of o-, and p-phthalic acids could not be confirmed. Diazoaminobenzene and rottlerin in boiling alcoholic solution gives 2:4:6-trihydroxy-3-acetyl-5-methyl-azobenzene, m. p.  $206^{\circ}C$ , which contains 2-3 active hydrogen atoms (Zerevitnov-Roth) and gives 1.6 molecules of acetic acid when oxidised by chromic acid (Kuhn-Roth). The substance is obtained synthetically from methyl-phloracetophenone, m.p.,  $213-214^{\circ}C$ . Analogously, methyl-phlorpropiofenone, m.p.,  $205^{\circ}C$ , is transformed into 2:4:6-trihydroxy-3-propionyl-5-methyl-azobenzene, m.p.  $211^{\circ}C$ . Methyl-phloracetophenone is also obtained by the thermal decomposition of rottlerin.

Mahal<sup>30</sup> has examined the flowers of *Tagetes erecta* or French marigold and has found that they contain quercetagetin.

Rao, Walewaker and Srikantan<sup>31</sup> from the aqueous extract of the rind of Purple-Mauritius sugar cane, have isolated an anthocyanin colouring matter, mauritin chloride, crystallising with four molecules of water, and giving violet colorations with sodium carbonate solution or alcoholic ferric chloride. The substance is hydrolysed by dilute sulphuric acid to mauritidin sulphate (m.p. above  $300^{\circ}C$ ) and glucose. By treatment with HI, the former is converted into a substance which is believed from its colour reactions to be delphinidin. Mauritidin contains one OMe group, and may be ampelopsidin, mauritin being its diglucoside.

Neelakantan and Seshadri<sup>32</sup> have isolated from the petals of Deccan Hemp (*Hibiscus cannabinus*) the colouring matter, cannabicitrin,  $C_{21}H_{22}O_{13}$ , which yields a monoacetate, and when hydrolysed, gives cannabicitin—a pentahydroxy-flavonol, differing from gossipetin, quercetagetin and myricetin.

Bose and Nath<sup>33</sup> give the formula  $C_{21}H_{22}O_9$  for gardenin, the colouring matter of Dikamali gum obtained *Gardenia gummifera*.

30 Mahal, H. S. (1938), *Jour. Ind. Chem. Soc.*, **15**, 87.

31 Rao, C. J. D., Walewakar, D. G. and Srikantan, B. S. (1938), *Ibid*, **15**, 27.

32 Neelakantan, K. and Seshadri, T. R. (1938), *Current Science*, **6**, 504.

33 Bose, P. K. and Nath, R. (1938), *J. Ind. Chem. Soc.*, **15**, 139.



With acetic anhydride, it gives acetyl gardenin, m.p. 136°C, and with alcoholic KOH, yields trimethy-gallic acid and a phenolic substance  $C_9H_8O_6$ , m.p. 158–160°C, which when reduced with sulphur dioxide yields a substance  $C_9H_{10}O_6$ , m.p. 175–176°C. With nitric acid, gardenin yields gardeninone,  $C_{20}H_{18}O_9$ , m.p. 222–224°C, together with 1 : 3 : 4 : 5- $C_6H_2(NO_2)_2(OCH_3)_3$  and 1 : 2 : 3 : 4 : 5- $C_6H(NO_2)_2(O-CH_3)_3$ . With  $SO_2$ , gardenine gives gardeninol, m.p. 184–185°C (diacetyl derivative m.p. 146–147°C). Since gardenin contains one hydroxy and six methoxy groups, and forms a double compound with stannic chloride in which the ratio of Sn : Cl = 1 : 3, the OH is probably at position 5 in the flavone nucleus, and gardenin is either 5-hydroxy—, 3 : 6 : 8 : 3' : 4 ; 5'—, or 3 : 7 : 8 : 3' : 4' : 8'—hexamethoxy-flavone.

Shah, Mehta and Wheeler<sup>34</sup> have brought about the synthesis of wogonin or 5 : 7—dihydroxy—8—methoxy-flavone by condensation of 2 : 4—dihydroxy—3 : 6—dimethoxy-acetophenone (Baker, Abs., 1929, i, 326) with sodium benzoate and benzoic anhydride. The product that is obtained is 7—hydroxy—5 : 8—dimethoxy-flavone, which by the action of HI is converted into trihydroxy-flavone and by  $AlCl_3$  under mild conditions into wogonin.

Neelakantan and Seshadri<sup>35</sup> have isolated from the petals of the Indian Tulip (*Thespesia populnea* Linn.), the colouring matter, populnin, m. p. 228—230°C (decomp.) in small quantities together with a much larger proportion of populnetin,  $C_{14}H_8O_6$ , m. p. 270—275°C (tetracetyl derivative, m. p. 127—129°C). The colour reactions indicate that populnetin is a tetrahydroxy-anthraquinone.

## 7. Miscellaneous.

Ganapathy and Sastri<sup>36</sup> have found that the latex of *Carica papaya* contains glutathione, which serves as an activator of papain. Other activators containing thiol groups are also present. (Cf. Grassman<sup>37</sup>).

34. Shah, R. C., Mehta, C. R. and Wheeler, T. S. (1938), *Current Science*, **6**, 503.

35 Neelakantan, K. and Seshadri, T. R. (1938), *Ibid*, **6**, 16.

36 Ganapathy, C. V. and Sastri, B. N. (1938), *Ibid*, **6**, 330.

37 Grassman, T. (1938), *Abs. III*, 452.



Ganapathy<sup>38</sup> has shown the presence of enzymic redox systems in the latex of *Carica papaya* by continuous aeration at  $p_{\text{H}}$  7.4, with or without preliminary heating. The  $p_{\text{H}}$  concerned in the first case falls continuously, but in the second case remains constant for a period and then falls. The addition of ascorbic acid does not affect the course of the reaction.

Dutt<sup>39</sup> has examined the molasses fusel oil from the Patent still of Messrs. Carew & Co., Ltd., of Rosa, Shahjehanpur, U.P., and by repeated fractional distillations with the help of two fractionating columns, has resolved it into the following constituents: (1) ethyl alcohol—1.2%, (2) isopropyl alcohol, 17.6%, (3) n—propyl alcohol, 3.2%, (4) water, 5.7%, (5) acetal, 1.6%, (6) isobutyl alcohol, 1.8%, (7) ethylisobutyrate, 0.7%, (8) n—butyl alcohol, 5.0%, (9) isoamyl alcohol, 60.9%, (10) n—hexyl alcohol, 0.2%, (11) furfural, 0.1%, (12) n—heptyl alcohol, 0.2%, (13) n—octyl alcohol, 0.7%, (14) melene, 0.04%.

38 Ganapathy, C. V. (1938), *Current Science*, **6**, 451.

39 Dutt, S. (1938), *Proc. Nat. Acad. Sci.*, **7**, 105.



## X. PHYTOPATHOLOGY—MYCOLOGY

by B. B. Mundkur.

Several important contributions on plant diseases have been made during 1938. A survey of relevant literature shows that there is a tendency among Indian Mycologists to give undue importance to the study of cultural characteristics of fungi, for papers on these subjects predominate. While the importance of knowing the physiological characteristics and cultural behaviour of the causal organisms of diseases cannot be minimised, the time has arrived when the correct identification of fungi and the questions of actual control of the diseases they cause should receive more attention at their hands.

### Cereals.

*Wheat*.—The mode of perpetuation and the method of controlling the leaf-spot disease of wheat due to *Septoria tritici* have been investigated by Luthra, Sattar, and Ghani<sup>1</sup>. They find that pycnosporos over-summer within the pycnia on diseased straw and initiate infection in the subsequent crop. The authors state that clean-up measures to check the spread of diseased plant debris are likely to eliminate the chances of infection. The *vulgare* and the *compactum* group of wheats are, according to them, susceptible to the disease while the wheats of the *durum* group have shown resistance. The more important and popular wheats of the Punjab belong, unfortunately, to the *vulgare* group.

'Sherbati', a Central Provinces wheat of hybrid origin, produced by crossing *Triticum dicoccum* (khapli) with *T. vulgare* (common) possesses, according to Bhatia<sup>2</sup>, considerable resistance to rust, which, he thinks, is due to the chromosomes from the 'khapli' parent, all of which probably carry rust resistant genes. He also states that segregates from the cross which had longer awns showed greater resistance to rust than those with shorter or no awns.

---

1 Luthra, J. C., Sattar, A., and Ghani, M.A. (1938), *Agr. and Livestock in India*, **8**, 17.

2 Bhatia, G. S. (1938), *Aun. Bot. n. s.* **2**, 359—364.



Bhatia does not mention which one of the three rusts affecting wheat he was dealing with, nor does he seem to have taken into consideration the phenomenon of parasitic specialisation, which may account for the apparent break-down of resistance in some of the resistant wheat varieties which he has cited. Unless tests are made with a single rust and a single physiological race of that rust, all theories regarding shuffling of chromosomes carrying genes for resistance are undoubtedly premature.

*Jowar*.—Vaheeduddin<sup>3</sup> has succeeded in producing a new physiologic race of *Shphacelotheca sorghi*, a fungus which causes the grain smut of Jowar (*Sorghum vulgare*). This race was obtained by hybridising the monosporidial lines derived from the promycelium of chlamydospores from a single smutted jowar kernel. The new parasitic race has not so far been found in nature but Vaheeduddin's work shows how new races of parasitic fungi, with a capacity to attack varieties of crop plants that had shown, until then, resistance to that particular fungus, arise in nature.

Three species of *Striga*, a genus of flowering plants, are known to attack the roots of and live parasitically on jowar in India. Kumar<sup>4</sup> reports that in a village near Poona yet another flowering plant, *Sopubia delphinifolia*, is parasitic on jowar roots causing considerable dwarfing of the host. Fyson had reported previously that this plant was parasitic on some grasses in South India but this is the first report of its occurrence as a parasite on this important crop plant.

### Legumes.

*Gram*.—In the north west Punjab, gram (*Cicer arietinum*) is subject of a severe blight due to *Mycosphaerella rabiei* (–*Ascochyta rabiei*). Seed disinfection and clean-up measures, formerly recommended, have not led to any appreciable control of the disease. Luthra, Sattar and Bedi<sup>5</sup> now report that three French varieties of gram show considerable resistance to

---

3 Vaheeduddin, S. (1938), *Phytopath*, **28**, 656.

4 Kumar, L. S. S. (1938), *Current Science*, **7**, 19.

5 Luthra, J. C., Sattar, A., and Bedi, K. S. (1938), *Ibid*, **7**, 45.



this blight, both in their artificial experiments and field tests. Two of these varieties resemble the local varieties and, in yield trials, compare favourably with them also. This discovery of already existing, but certainly not newly evolved, resistant varieties is very interesting, but their performance against certain other gram diseases, especially wilt and rust, is worth observing.

*Pigeon-peas*.—Wollenweber<sup>6</sup> reports that pigeon-pea plants (*Cajanus cajan*) that had wilted in a typical manner in the fields at Pusa yielded cultures of *Fusarium lateritium* var. *uncinatum*. In infection experiments conducted at Berlin Dahlem the fungus caused a severe foot-rot of this crop. This experiment indicates that at least two species, *F. vasinfectum* and *F. lateritium* var. *uncinatum*, cause disease of pigeon-peas in India, making the problem of producing disease resistant pigeon-pea varieties, a bit more complicated.

Bose<sup>7</sup> finds that the intensity of pigeon-pea wilt can be considerably reduced in wilt-sick fields if pigeon-peas are rotated with tobacco. In soils receiving heavy artificial infection, he has noted that the stand of pigeon-peas was maintained for a much longer period than in ordinary soil. In addition to using wilt resistant varieties, Bose advocates therefore a pigeon-pea—tobacco rotation.

*Soy-beans*.—A leaf spot disease hitherto unrecorded for India on soy-beans (*Glycine max* (L.) Merr.) was observed by Uppal, Patel and Kamat<sup>8</sup> on the Jalgaon farm in the Bombay Presidency. In extreme cases petioles and stems were also affected. The causal organism has been identified to be *Phytophthora phaseoli* var. *sojense*. The bacterium is restricted to this particular host, for other leguminous plants failed to take infection.

---

6 Wollenweber, H. W. (1938), *Arb. Biol. Reichsanst. Land. Forstw.* **22**, 339.

7 Bose, R. D. (1938), *Agr. and Livestock in India*, **8**, 653.

8 Uppal, B. N., Patel, M. K. and Kamat, M. N. (1938), *J. Univ. Bombay*, **6**, 16.



## Vegetable and Drug Crops.

*Potatoes.*—In a paper read before the Science Congress at Calcutta, Salaman<sup>9</sup> has surveyed the present status of the efforts in potato breeding and the lines along which future developments should take place. He deals at considerable length with the question of 'late blight' resistance in potatoes and resistance to virus diseases. The importance of the new potato varieties and tuber-bearing *Solanum* species containing within them genes for resistance to late blight (*Phytophthora infestans*), brought from South America by Russian and other expeditions, is emphasized and the work done at the Potato Research Station at Cambridge, to obtain economically sound varieties resistant to this disease, has been outlined. It is heartening to know that *Solanum Rybini*, a tuberbearing species, is completely resistant to the "y" virus and leafroll, and that varieties have been evolved in the United States which are highly resistant to the "x" virus.

Efforts that are being made in India to improve potato stocks using the new South American material, with a view to control late blight and virus diseases, have been summarised in a communication by Pal.<sup>10</sup>

Singh and Mathur<sup>11</sup> have discovered that potato tubers of middle dormancy stage are more susceptible to the 'black-heart' condition than those of adolescence or late dormancy stages. They also state that there is an indication that smaller tubers are less likely to contract 'black-heart' than the bigger ones.

*Cumin.*—A blight cumin (*Cuminum cyminum*) which occurs sporadically in the Kaira district has been investigated by Uppal, Patel and Kamat.<sup>12</sup> Minute necrotic areas first start on the leaves and, ultimately, all aerial parts are involved. The fungus responsible for this disease seems to be a new species of *Alternaria*, which the authors have named *Alternaria Burnsii*. The fungus over-summers on diseased plant residues but the authors consider

9 Salaman, R. N. (1938), *Ind. Jour. Agr. Sci.*, **8**, 119.

10 Pal, B. P. (1938), *Agr. and Livestock in India*, **8**, 388.

11 Singh, B. N. and Mathur, P. B. (1938), *Phytopath*, **28**, 705.

12 Uppal, B. N., Patel, M. K. and Kamat, M. N. (1938), *Ind. Jour. Agr. Sci.*, **8**, 49.



that infected seed may play an important role in the perennation of the fungus and in initiating primary infection.

*Betel vines*.—A hitherto unrecorded powdery mildew of betel vines (*Piper betle*), at present confined to Bassein, near Bombay, has been described by Uppal, Patel and Kamat.<sup>13</sup> One or at the most two dustings at the proper time with sulphur powder of the order of 200 mesh fineness, gives complete control of the disease in the field. The causative agent seems to be a new species which the authors propose to name as *Oidium piperis*. The authors may be aware that a powdery mildew of this same plant has been reported from Burma as well.

*Sarson*.—The smut which causes galls on the roots of sarson, *Brassica campestris*, has been re-investigated by Mundkur.<sup>14</sup> He has shown that considerable reduction in mustard yields may be caused by its attack. The smut is soilborne and the spores may remain viable in the soil for several years. The smut was able to attack other *Brassicas*, such as rai, toria, turnip, radish, and cabbage. On comparing this smut with *Urocystis coralloides*, which causes galls on the roots of some other cruciferous plants in Europe, he found that the indian species was new, which he has named *Urocystis Brassicae*.

### Cotton.

Before a conference of scientific workers on cotton in India, Uppal<sup>15</sup> read an important paper on breeding cotton resistant to wilt caused by *Fusarium vasinfectum*. The principles which should guide investigators in laying down a sound programme for selecting wilt resistant varieties of crop plants, the importance of adequately taking into consideration, and at an early stage, the degree of soil infestation, the genetic variability of the host and the pathogen and above all the potent influence of environment, have been stressed so that errors made in distinguishing a truly resistant from an apparently resistant plant may be avoided. The technique employed at Poona in the production of wilt resistant

---

13 Uppal, B. N. and Kamat, M. N. (1938), *Current Sci.*, **6**, 611.

14 Mundkur, B. B. (1938), *Phytopath*, **28**, 134.

15 Uppal, B. N. (1938), *Proc. of Conf. of Cotton Workers in India*, 1937,



strains of cotton, keeping in mind the principles enunciated above, and the rigorous tests applied for selecting truly resistant plants, have been given in considerable detail. In Egypt inheritance of wilt resistance in cotton seems to be due, in certain varieties, to a single dominant Mendelian factor and, in others, to several genes which act in a cumulative manner. In India, according to Uppal, there are clear indications that wilt resistance is controlled by cumulative genes, but whatever the mode of inheritance, Uppal opines that better results would follow if selections are made under proper optimum conditions of infection.

Luthra and Vasudeva<sup>16</sup> have compared the species of *Rhizoctonia* which they had isolated from root-rot affected cotton plants and which they had tentatively called *R. bataticola* with a culture of the same fungus identified by Hopkins. The two isolates agree very well in their cultural and morphological characters. Haigh has sub-divided the species *R. bataticola* into three groups, A, B, and C on the basis of sclerotial size and it would have been interesting if the authors had determined the group to which the Punjab strain belonged. According to Ashby some isolates of *R. bataticola* form pycnia on sesamum or jute plants, in which case the fungus is called by the name applied to the pycnial stage, *Macrophomina phaseoli*. The capacity of the Punjab cotton strain of *R. bataticola* to form this stage yet remains to be determined. It may be of interest, however, to note that the genus *Macrophomina* which was founded by Petrak, has been now merged by him into the genus *Dothiorella*, so that the name that should be applied to the pycnial stage of *Rhizoctonia bataticola* still remains to be ascertained.

## Fruits.

*Oranges.*—Ghatak<sup>17</sup> has studied the storage rot of Darjeeling and Assam oranges due to two strains of *Fusarium moniliforme*. The first manifestation which these fungi cause on the fruit is a small water soaked area on the skin with a light brown colour and a white patch in the centre. In advanced cases the whole surface

---

16 Luthra, J. C. and Vasudeva, R. S. (1938), *Ind. Jour. Agr. Sci.*, **8**, 727.

17 Ghatak, P. N. (1938), *Jour. Ind. Bot. Soc.*, **17**, 141.



is covered by a white incrustation and the fruit ultimately becomes a pulpy mass. Infection experiments have shown that the fungi are wound parasites and that the Nagpur oranges are relatively less attacked.

Prasad<sup>18</sup> reports a rot of pears due to a species of *Aspergillus* which he thinks is *A. japonicus* Saito.

### Sugarcane.

The occurrence of the stem-canker disease of sugarcane due to *Cytospora Sacchari* in the Punjab has been reported by Luthra, Sattar and Singh.<sup>19</sup> When conditions are favourable, the fungus has been found to cause a severe wilt of canes.

The same authors<sup>20</sup> have also studied the life history and the mode of perpetuation of the sugarcane smut caused by *Ustilago scitaminea*. They find that chlamydospores best germinated in glucose solution and in a dilute infusion of sugarcane leaves. The optimum temperature for germination was found to be over 30°C and optimum pH was 6.4. The spores when kept dry remained viable for over 210 days. The authors consider that in the Punjab, as indeed elsewhere, the disease is carried over from year to year in setts from smutted canes and in ratoon canes. The statement of the authors that the disease occurs in Louisiana and in Brazil is questionable as sugarcane smut is not known in the western Hemisphere.

Subramaniam and Chona<sup>21</sup> have published the report furnished by E. W. Mason and G. R. Bisby of the Imperial Mycological Institute, on two cultures of '*Cephalosporium Sacchari*' and one of '*Fusarium moniliforme*' isolated from diseased sugarcane plants. The former, according to Mason and Bisby, does not seem to be a typical *Cephalosporium*, though it is of the same type as *C. Sacchari*, but the identification of the latter has been confirmed. Subramaniam and Chona think that *C. Sacchari* belongs to the *Fusarium monili-*

---

18 Prasad, H. H. (1938), *Ind. Jour. Agr. Sci.*, **8**, 549.

19 Luthra, J. C., Sattar, A. and Singh, S. (1938), *Proc. Ind. Acad. Sci.*, **8B**, 188.

20 Luthra, J. C., Sattar, A. and Singh, S. (1938), *Ind. Jour. Agr. Sci.*, **8**, 849.

21 Subramaniam, L. S. and Chona, B. L. (1938), *Ibid*, **8**, 189.



*forme* group, but in the absence of the type culture of Butler and Hafizkhan's *Cephalosporium Sacchari*, it does not seem proper to come to any conclusion regarding the status of this species, especially because the cultures studied were neither typical of *Cephalosporium* or produced wilt in sugarcane, which Butler and Hafizkhan's fungus did.

### Miscellaneous Diseases.

*Sandalwood*.—In the nineteenth contribution to a study of the spike disease in sandal (*Santalum album*), Iyengar<sup>22</sup> reports that in spike diseased trees, the calcium-nitrogen and the nitrogen-ash ratios were primarily affected, the former being uniformly low for the affected specimens. He also finds that the ratio of length to breadth of the diseased leaves is significantly higher and that the leaf-stalk is characteristically shorter in length than that of healthy plants. According to Iyengar the physical and the biochemical indices are the surest aid in correctly diagnosing the disease.

The same author<sup>23</sup> has summarised the work done on this disease during the past several years and has discussed the salient points that have been brought to light by these investigations. Iyengar states that due importance should be given for the prompt elimination of all possible factors that contribute to the spread of the disease. The removal of diseased sandal plants and of the affected alternate hosts is advocated and the use of toxic chemicals for their eradication is said to hold forth considerable promise. The announcement of Dover that the sap-sucking insect, *Moonia albimaculata*, is responsible for transferring the disease or the claims of Chatterjee that a beetle may be a possible vector, are not accepted by Iyengar who thinks that the problem of the carrier is still obscure. Investigations on spike disease of sandal are complicated by the fact that the sandal tree itself is a root parasite and the host to which it attaches itself may determine the health and predisposition of the plant to this disease. Observations seem to have shown that one of the hosts, a

---

22 Iyengar, A. V. V. (1938); *Jour. Ind. Inst. Sci.*, **21A**, 89.

23 Iyengar, A. V. V. (1938), *Phytopath.*, **28**, 715.



species of *Lantana*, occurs in abundance in those areas where the incidence of the disease is very high.

*Rubber*.—Mitra and Mehta<sup>24</sup> report that in a rubber plantation in Travancore, an abnormal leaf-fall of rubber trees was due to *Oidium Heveæ* and *Glæosporium alborubrum*, fungi hitherto unrecorded for India.

*Jasmine*.—A popular account of jasmine rust, *Uromyces Hobsoni* and methods for its control are given by Kamat.<sup>25</sup> The disease appears late in the rainy season causing a malformation and distortion of the flowering shoots. As the season advances, affected parts turn black. Kamat recommends a judicious pruning to remove affected parts at the beginning of the monsoon and spraying with 3-3-50 Bordeaux mixture when new shoots are about one to one and a half feet long, followed by another spray at the commencement of the cold season.

Thirumalachar<sup>26</sup> has made an important contribution to our knowledge of this same rust, *Uromyces Hobsoni*, found by him on *Jasminum grandiflorum*. Pycnia, only few of which were observed in leaf sections by Barclay and none at all by Ajrekar and Parandekar, were macroscopically made out in abundance on flower buds leaves and stems. In rusts the pycnospores are borne on haploid gametophytic mycelia but Thirumalachar finds that in this rust they are borne on binucleate, dicaryotic, mycelia and not only that but even the basal pycnial cells, below the pycnospores, are binucleate. He has observed fusions between pycnospores and hyphae at the ostiole, confirming similar fusions recently recorded by Buller in *Puccinia graminis*. The fusion of the haploid pycnial nuclei and the haploid cells of the aecium have been noted in other species of *Uromyces* by Andrus but the significance of the fusion of diploid spermatial cells with hyphae, observed by Thirumalachar, is not evident. But the most remarkable discovery made by him is that from the basal part of the mature pycnocarp, aeciospores and teliospores arise, which

---

24 Mitra, M. and Mehta, P. R. (1938), *Ind. Jour. Agr. Sci.*, **8**, 185.

25 Kamat, M. N. (1938), *The Gardener*, **2**, 114.

26 Tirumalachar, M. J. (1938), *Jour. Ind. Bot. Soc.*, **17**, 295.



development was presumably made possible on account of the diploid condition of the basal cells. But at what stage diplodization took place and where the gametophytic phase ended, remains to be discovered. By definition, the pycnospores have to be uninucleate. Whether the dicaryotic spores of this rust can be considered as pycnospores remains also to be determined. In any case this discovery may throw some new light on the phenomenon of sex and organography in the Uredineae and of fungi in general.

### Physiology and Cytology of Fungi.

Bose<sup>27</sup> has reported the result of his investigation on the effect of solar-radiation, ultra-violet rays, X-rays and radium on the growth of three *Polypores*, *Polystictus leoninus*, *Polyporus ostreiformis* and *Trametes cingulata*. Most of the effects that were produced were only of temporary nature. Solar radiation and ultra-violet rays caused damage both to the vegetative and reproductive phases though there was, ultimately, a reversion to the normal state. Direct sunlight combined with higher temperature minus ultra-violet rays had a much more pronounced killing effect. Exposure to X-rays did not produce any mutant involving genic change. Development of reproductive bodies was almost entirely suppressed in *P. ostreiformis* though in *P. leoninus* and *T. cingulata* fruit formation was only partially affected. Radium rays had the effect of retarding the vegetative growth, damaging hyphae, suppressing spore formation and causing imperfect development of fruiting structures. Later, however, recovery from these effects was noted in sub-cultures, being quicker in the vegetative than in the reproductive phase. It will thus be noted that hardly any heritable changes had been produced in these *Polypores*. Bose thinks that genic changes can be brought about by the action of ultra-violet rays, X-rays and radium only in those plants whose genes are in a flux and an unbalanced state.

In further experiments on the production of perithecia in a species of *Rosellinia*, Das Gupta<sup>28</sup> states that in the absence of a contaminating bacterium, the fungus is unable to form perithecia. He also finds that the number of perithecia formed decreases as

27 Bose, S. R. (1938), *Jour. Ind. Bot. Soc.*, **17**, 6.

28 Das Gupta, S. N. (1938), *Proc. Ind. Acad. Sci.*, **7B**, 22.



the concentration of asparagin and potassium nitrate increases. There was an increase as the concentration of agar increased but the addition of glucose to a medium having a relatively high content of  $\text{KNO}_3$  not only reduced the size of the perithecia but had a deleterious effect even on their free production.

Under the direction of Professor Saksena cytological studies of certain members of the family Saprolegniaceae have been started by Murdia.<sup>29</sup> In the present preliminary paper, methods of supravital and intravital staining are described together with new methods recently devised, for better fixing of fungous material. For supravital and intravital staining Murdia finds that neutral red is the least toxic stain and a satisfactory dye for making observations on living material.

### Systematics.

Chaudhuri and Umar<sup>30</sup> have listed the species of *Aspergilli* occurring in India. Cultural characters in some cases have been given. There seems to be, according to these authors, 31 species of this genus represented in India to which will have to be added *A. Japonicus*, reported by Prasad on pears, if that identification is correct.

In a second paper Chaudhuri<sup>31</sup> has catalogued 15 species of *Penicillium* and one of *Scopulariopsis*, a related genus, which have also been reported to occur in this country.

A fungus found on the rotting dicotyledonous leaves and bark of certain plants and also the living megasporophylls of *Cycas revoluta* is considered to be a new species of *Emericella* by Choudhuri and Mathur<sup>32</sup> which they have named *E. medias*. The genus *Emericella* was very imperfectly described by Berkeley, and Massee once thought that it was a Gasterolichen. There is a necessity for a detailed study of this genus, especially in its relation to other genera of the family Aspergillaceae.

---

29 Murdia, M. S. (1938), *Jour. Ind. Bot. Soc.*, **17**, 301.

30 Chowdhuri, H. and Umar, M. (1938), *Proc. Ind. Acad. Sci.*, **8B**, 69.

31 Chaudhuri, H. (1938), *Ibid*, **8B**, 93.

32 Chaudhuri, H. P. and Mathur, R. S. (1938), *Ann. Mycol.*, **36**, 61.



Mundkur<sup>33</sup> reports the occurrence of *Urocystis sorosporioides* at Simla. It seems to have been collected by Bagchee at Chakratha also.

A rust found on *Acacia modesta* at Delhi has been found by Mundkur and Prasad<sup>34</sup> to be a new species of *Ravenelia* which they have named *R. Taslimii*.

Bose<sup>35</sup> reports that he has found heavily encrusted cystidia in the basidial layer within the pore tubes of *Polyporus zonalis*. This important and reliable diagnostic anatomical feature had apparently not been noticed before by other workers.

The bigger pores of *Daedalea flavida* have been found by the same author<sup>36</sup> to be lined with a fringe of dead and thick walled tramal hyphæ. When the basidia increase in the course of the spore-fall, the fringe sinks down and disappears but it reappears when basidia decrease with a decrease in the spore-fall. This seems to be a constant character, so far unrecorded, in *Daedalea* with considerable diagnostic value.

Ulbrich<sup>37</sup> has reported upon the fungi collected by Dr. Troll, geographer and botanist to the German Himalayan Expedition of 1937, in Kashmir, Gilgit and the region of the Nanga Parbat between 7500 to 12500 feet above sea level. The fungi are exclusively rusts and consist of three species of Melampsoraceae, seven of Pucciniaceae and three of Uredineae Imperfecti. There are three new species, *Melampsora Saliciswallichianae*, *Uromyces Trolli-caroli* and *Aecidium Colchiciaurei*. Ulbrich has erected the genus *Trolliomyces* to accomodate the interesting rust on *Rosa webbiana* which Barclay, in 1889, had named *Puccinia Rosae*. This rust had been placed by Arthur and Cummins, in 1933, in the genus *Phragmidium* and named *P. Kamtschatke* but Ulbrich has adduced reasons to show that the fungus does not belong to that genus. Ulbrich's genus *Trolliomyces* is not, however, valid, for Sydow had,

---

33 Mundkur, B. B. (1938), *Trans. Brit. Myc. Soc.*, **21**, 240.

34 Mundkur, B. B. and Prasad, N. (1938), *Mycologia*, **30**, 685.

35 Bose, S. R. (1938), *Ann. Mycol.*, **36**, 154.

36 Bose, S. R. (1938), *Mycologia*, **30**, 683.

37 Ulbrich, E. (1938), *Notiz. Bot. Gart. u. Mus. Berlin-Dahlem*, **14**, 139.



in 1921, already founded the genus *Teleconia* for this rust, a fact of which Ulbrich was evidently not aware.

Mitter and Tandon<sup>38</sup> have enumerated the fungi found by them in Nainital. Three species belonging to the Hymenomycetes and two to Fungi Imperfecti are new records, not having been listed in the Fungi of India or its supplement. An imperfect fungus, *Aulographopsis indica*, found on a fern is presumably to be described as a new species, and belonging to a new genus, by Petrak.

The same authors<sup>39</sup> have given a list of 99 fungi collected and identified for them, from Mussoorie and its environs. Of these, one Hymenomycete is a new record. Descriptions of nine species is given as that of *Novo Species*. As these species had already been described as new in 1933, 1935 and 1937 in other publications it does not seem appropriate to designate them again as new. The name of the smut on *Selaginella chrysocaulos* and *S. chrysorrhizos* is not *Melanotaenium Selaginellae* Syd. as stated by these authors but *Melanotaenium oreophilum* Syd. Authorities for *Melanotaenium Selaginellae* are Hennings and Nyman who described it in 1899 from Java.

Fungi collected by Mr. Sultan Ahmad in the Kulu valley and the surrounding Himalayan regions, right up to Rohtang pass and Lahul, where mycological explorations had not been made before, have been determined by Sydow.<sup>40</sup> The seventy collections have been found to consist of forty-four species. Of the six smuts, one is a new species and two are new records for India; of the thirty-five rusts, three are proposed as new species and four are new records; of the two powdery mildews, one is a new record, and the single species of *Sphaeriales* reported in the paper is also a new record. There were thus four new species and eight new records in the collection. The smut, *Ustilago nepalensis*, which was known so far from Tibet, and of which there was only a single specimen in the Liro herbarium in Finland, was in this collection. A concerted effort to identify the fungi in India itself, or send them abroad, when such efforts

38 Mitter, J. H. and Tandon, R. N. (1938). *Jour. Ind. Bot. Soc.*, **17**, 177.

39 Mitter, J. H. and Tandon, R. N. (1938). *Proc. Nat. Acad. Sci.*, **7**, 175.

40 Sydow, H. (1938), *Ann. Mycol.*, **36**, 437.



fail, making proper provision for receiving back part of the specimens, so as to preserve for our country's herbaria rare specimens and also type specimens, seems to be highly desirable.

Seventeen collections of smuts made in the Punjab and Kashmir by R. R. Stewart and I. D. Stewart have been determined by Clinton and Zundel.<sup>41</sup> These were found to group into eleven species, of which four are new records for India. There were some new hosts for some of the smut species, which had not been previously recorded here.

A supplement to Butler and Bisby's *Fungi of India* has been published by Mundkur.<sup>42</sup> Myxomycetes, left out in the earlier publication, have been now included. While the pathogenic fungi predominated in Butler and Bisby's work, aquatic, coprophilous and soil fungi are well re-presented in the present list. This is, in a large measure, due to investigations carried out in many of the Indian Universities whose staffs have enthusiastically taken to their study. One new species and five new combinations are included. The total number of fungi recorded in the *Fungi of India* and its supplement is 2874 species, to which should be added 45 species recorded during the year, which brings the total for India to 2919 species.

41 Clinton, G. P. and Zundel, G. L. (1938), *Mycologia*, **30**, 280.

42 Mundkur, B. B. (1938), *Imp. Council. Agr. Res., Sci. Monog.* 12.



## XI. PHYTOPATHOLOGY-ENTOMOLOGY

*By K. B. Lal.*

The most notable event of the year, which is bound to stimulate interest in entomological research in this country, was the inauguration of the Entomological Society of India during the Silver Jubilee Session of the Indian Science Congress. The Society is to encourage, in all ways, interest in the study of insects and arrange for discussions of entomological problems. It has also decided to publish a journal which should bring together a large proportion of entomological papers and notes now scattered about in a number of periodicals not primarily devoted to entomology. It is to be hoped that the papers published in the Journal will add to the interest and variety of the subjects reviewed in these pages hereafter.

The main centres of entomological research in India, active in publication during the year under review, were the Imperial Agricultural Research Institute, New Delhi, the Forest Research Institute, Dehra Dun and the Agricultural College and Institute, Coimbatore. The papers published show considerable attention paid to the study of fruit pests and to the natural enemies of insect pests of crops, specially sugarcane. Interest in systematic work on various groups was also well kept up.

### **Insect Pests.**

The occurrence of the notorious codling moth in Baluchistan, a pest of apples, pears, etc., in almost all the fruit growing areas of the world, was reported by Pruthi in 1935 for the first time from the Indian region. Early in the year under review, the same author<sup>1</sup> published further record of the occurrence of this pest in the North West Frontier Province, and considered it almost certain that it occurred also in Afghanistan and Kashmir. In view of these facts the author suggested the necessity of

---

1 Pruthi, H. S. (1938), *Agri. and Live Stock in India*, 8, 42.



carefully examining fruit growing tracts of the Punjab and eastern United Provinces for this pest.

Pruthi<sup>2</sup> followed up his discovery of the codling moth in Baluchistan with an account of its life history, distribution and status in Baluchistan, together with shorter studies of three other pests of apples in the same area, namely, the bud moth, *Spilonota ocellana* Schiff., *Euzophera punicella* Moor and *Cacoecia sarcostega* Meyr. The codling moth is a serious pest in Quetta-Pishin district and several other but not all districts of Baluchistan having elevations between 4500 to 6000 feet and the cause of the absence of the pest from an area very near to an infested area, though having the same latitude and altitude, appears to be the difference in climatic conditions created by the closeness of the mountain ranges in the latter and the openness of the country in the former. Larvae of the codling moth damage fruits by boring into them and feeding inside, those of *E. punicella* generally occur in apples already damaged by codling moth, while larvae of *C. Sarcostega* and *S. L. ocellana* are primarily leaf and bud feeders though the former may sometimes be also found in fruits damaged by codling moth. Apple, pear and quince were observed to be the most favourite hosts of the codling moth: these and several other fruits such as peach, apricot, plum etc., were attacked by the other moths. In Baluchistan the codling moth adults emerge from mid-April to about the 10th May from the overwintering larvae of the previous winter and lay eggs on leaves, twigs, flowers etc., of their hosts. The larvae bore into young fruit and when full fed come out and pupate under bark etc. The larvae of the second brood are full grown by the end of September, when they leave the fruit and overwinter as larvae in cocoons formed by themselves. The moths were found to live about 8 days at Quetta and about 4 to 12 days at New Delhi, depending upon temperature and humidity. Female moths lived longer than males and on average laid about thirty eggs. The author has given reasons for the view that the introduction of the codling moth into the North West Frontier Province and Baluchistan must have been from Afghanistan when infested fruits began to be imported into Quetta

---

2 Pruthi, H. S. (1938), *Ind. Jour. Agric. Sci.*, 8, 499.



and Parachinar from Chaman and other places following upon the extension of the railway line between these two places.

Ahmad<sup>3</sup> studied the life history of the tur pod fly, *Agromyza obtusa* Mall., well known in India as an important pest of *Cajanus cajan* since over the last 30 years, but the specific name of which is published for the first time in the paper under review. Damage is caused by the larvae of the fly feeding on the soft seeds of the pods. The pest, which is widely distributed in India, may have 2-3 generations from October to April when it occurs in the field at Pusa and New Delhi, but how it passes the intervening period of summer and autumn is still to be discovered. The immature and adult stages were studied under three different temperatures, in most cases in a saturated atmosphere, and the most favourable temperature for their development seemed to be that prevailing in the room, namely 23-28°C. Adults, when supplied with honey solution lived twice as long as when starved. Of the two Chalcid parasites bred from the fly, one, an Eulophid, seemed to exercise good check on it in the field. The tur pod fly appears to be monophagous as no alternative host plants are so far known.

During the last two decades two important crop pests most thoroughly studied in the Punjab have been the desert locust and the pink bollworm. Observations relating to the life history, distribution, status etc. of the latter insect have been published in a series of papers of which the fourth is under review. In this paper Khan<sup>4</sup> has discussed the incidence of *Platyedra gossypiella* Saund. in relation to climate in the light of work carried out from 1926 to 1931 at twelve different stations distributed all over the Punjab. The author confirms the previous finding of his own and of other authors that the incidence of the pink bollworm is practically nil in the western districts, low in the canal colonies but rises in the central and sub-montane districts extending well to the south eastern districts. This distribution can be roughly correlated with the four zones into which the Punjab may be divided with respect to its rainfall, although the author is careful to point out that rainfall is taken merely as an

---

3 Ahmad, T. (1938), *Ind. Jour. Agric. Sci.*, **8**, 63.

4 Khan, M. H. (1938), *Ibid*, **8**, 191.



index of certain climatic conditions of the province, which may, however, be determined by other factors elsewhere.

Richards<sup>5</sup> published some observations on the stripping of dry-cane leaves as a preventive against *Pyrilla* attack. Stripping was practised on the Cawnpur farm before 1935 and was later extended to the farms at Muzaffarnagar and Bulandshahar. The results of analysis of juices from stripped and unstripped canes were in favour of the former. All the strippings were, however, done in September, so that a considerable proportion of the eggs laid on the green leaves still present on the plant, must have escaped destruction. It is, therefore, difficult to decide whether the beneficial effect of stripping could be really attributed to any decrease in *Pyrilla* population or to the purely cultural advantages of the method, specially as the author himself remarks, that even in the absence of *Pyrilla* stripping of cane leaves during the latter part of the monsoon is in itself an useful economic practice.

Cherian and Basheer<sup>6</sup> studied the life history of *Sticodiplosis moringae* Mani, a Cecidomyid attacking the flower buds of *Moringa pterygosperma* in Madras. Maggots of the fly were found in the flower buds all the year round at Coimbatore but were most abundant in November and December. The authors suggest working up the soil underneath the plants to destroy the pupae hidden in them.

Mites are not insects but closely related to them and the damage done by them to cultivated plants is rightly considered an entomological problem of which there are several in India. Cherian<sup>7</sup> has given a list of mites infesting some economic crops in South India, wherein short accounts including methods of their control are given of the following species.—*Tetranychus telarius*, *T. bioculatus* Wood Mason, *T. hindustanicus* Hirst, *Tetranychus* sp., *Paratetranychus indicus* Hirst, *P. punicae*, *Eriophyes carinatus* Green, *E. gossypiella*, *Tetranychus fici* Hirst.

---

5 Richards, P. B. (1938), *Agr. and Live Stock in India*, 8, 259.

6 Cherian, M. C. and Basheer, M. (1938), *Madras Agric. Jour.*, 26, 92,

7 Cherian, M. C. (1938), *Agr. and Live Stock in India*, 8, 537.



Cherian and Pillai<sup>8</sup> studied the life history of the Geometric moth *Semiothisa* (*Macaria*) *pervolgata* Wlk., the larvae of which do severe damage to *daincha* (*Sesbania aculeata*) crop in the Madras presidency. The insect, which is recorded for the first time as a pest, though its host plant is only useful as a green manure, was abundant in the field by the middle of May but was checked in June by the appearance of Braconid parasite. The life cycle from egg to the adult occupied 17—24 days. Insecticides and baits were neither effective nor economical but results with light traps were encouraging. The authors recommend hand netting and destruction of the adult moths.

Pruthi and Batra<sup>9</sup> published an annotated list of 55 fruit pests of the North West Frontier Province of which about one fourth can be regarded as of major importance. The fruit trees kept under observation for their pests were peach, plum, ber (*Zizyphus jujuba*) apricot, apple, pear, orange and other citrus fruits, grape vine, guava, fig, mango, olive and melons and other cucurbits. The insects found attacking them or their fruits are mentioned under their hosts and information on their distribution, nature and extent of damage, and wherever available, alternative host plants, seasonal history, natural enemies, etc., are given. Several of the insects noted are well known in Europe, America and other countries as serious pests, e. g. *Myzus persicae* Sulz., *cydia pomonella* Linn., *Aspidiotus perniciosus* Coms., and *Schizoneura lanigera* Hans.

Subramaniam and Ananatanarayan<sup>10</sup> studied the life history of a Lasiocampid moth, *Metanastria hyrtaca* Cram., whose caterpillars were found defoliating some *sapota* plants at Coimbatore. In South India only two species of Lasiocampidae, *Taragama Siva* and *Tarabala Vishnu* are usually known to become pests occasionally and the authors regard the present species as third of the same kind. The life history from egg to adult took 75 to 109 days but the period of the year when it was worked

8 Cherian, M. C. and Pillai, B. R. (1938), *Madras Agric. Jour.*, **26**, 166.

9 Pruthi, H. S. and Batra, H. N. (1938), *Imp. Coun. Agric. Res. Misc. Bull. No. 19*.

10 Subramaniam, T. V. and Ananthanarayan, K. P. (1938), *Jour. Bom. Nat. Hist. Soc.*, **40**, 257.



is not stated. Caterpillars were found to be gregarious. The list of alternative food and host plants includes *Terminalia catappa*, *Eugenia jambolana*, *Albizzia stipulatas* and *Acacia arabica*. The authors recommend hand picking and stomach poisons as measures of control.

Ayyar<sup>11</sup> studied the bionomics of leaf eating caterpillars of two species of Pyralid moths, *Pycnarmon Cribrata* F. and *Phostria piasusalis* W., damaging *Coleus parviflora*, a vegetable crop in Malabar. These species were not noted as pests from any part of India before and were recorded from South India for the first time. Larvae of *P. Cribrata* feed under cover by folding a leaf longitudinal inwards, those of *P. Piasualis* also feed in the same way but by webbing a number of top shoot leaves of the plant. The former were found heavily parasitised by the Braconid, *Microgaster Psarae* W., which seemed to exercise fairly efficient natural control.

Brahmachari<sup>12</sup> studied the bionomics of the bagworm, *Kophene cuprea* M., on Banana. The caterpillars, which usually numbered 10 to 150 on a leaf, were observed to feed on the lower surface of plantain leaf scraping the epidermis when young and eating the leaf in small bits and causing perforations in it as they grew older. They were also helped in their dispersal by the leaves of the neighbouring plants touching one another. The period from egg to the emergence of the adults occupied 3 months of which larval activity took  $2\frac{1}{2}$  months. It is stated that different genera of Psychids utilise different materials for making their bags (which the larvae spin and carry about with them) whose shape, size and mode of attachment to the host plant also differs. According to the author, Ichneumonids, Tachinids and Bombylids attack Psychid larvae, the first named being specially partial to them. The Cryptid, *Goryphus nursei* Cam., was bred from the larva of *Clania crameri*.

Subramaniam<sup>13</sup> gave brief notes on the bionomics and control of the tobacco stem borer, *Phthorimaea heliopa* Lw., a serious pest

11 Ayyar, T. V. R. (1938), *Jour. Bom. Nat. Hist. Soc.*, **40**, 336.

12 Brahmachari, K. (1938), *Ibid*, **40**, 56.

13 Subramaniam, T. V. (1938), *Mysore Agric. Calendar*, p. 13.



of tobacco in Mysore. Some protection to seedlings was afforded by spraying with calcium arsenate at 5-day intervals. The author recommends the uprooting and destruction of tobacco after harvest, so that they may not act as foci of infection for the future crops.

### Plant Viruses.

The discovery of the insect vector of the spike disease of sandal continues to be as elusive a problem as ever. Chatterji<sup>14</sup> published the thirty-third paper on the insect fauna of sandal plantations in South-India and listed species belonging to the Heteropterous families, Pyrrhocoridae, Aradidae, Tingitidae, Hydrometridae, Phymatidae, Capsidae, Pelogonidae and Notonectidae, collected while frequenting sandal foliage.

### Biology of parasites and predators.

Interest in the natural enemies of various crop pests with a view to exploring the possibilities of controlling the latter by biological means referred to in the last year's Review has continued unabated. During 1938 ten papers were published in this line, of which one is reviewed under the sub-heading of taxonomy. Six of these papers deal with the parasites of pests of sugarcane, an indication of the growing importance of the crop as well as of the difficulty of dealing with its pests by insecticidal and other methods.

Cherian and Israel<sup>15</sup> recorded their observations on the biology of *Stenobracon nicevillei* Bing., a Braconid parasite of the cane shoot borer, *Scirpophaga nivella* F., synonym of *S. auriflua* Zell., from which the first specimens of the parasite are recorded to have been reared. At Coimbatore the parasite was common in cane and sorghum fields from March to August and in the laboratory was bred from such borers as *Chilo* and *Sesmia* spp., *Diatraea sticticraspis* Hmps. and *D. venosata*. The female parasite oviposits on a host larva only when it is inside its burrow: exposed larvae and pupae were generally rejected. The life cycle of the parasite took from 14 to 21 days so that under favourable conditions it could run into three

---

14 Chatterji, N. C. (1938), *Ind. For., Rec., Ent. Ser.*, **3**, 213.

15 Cherian, M. C. and Israel, P. (1938), *Bull. Ent. Res.*, **22**, 99,



generations as compared to one of the host. Other points in its favour are said to be its probable freedom from hyperparasites, the convenience of rearing it artificially and its virtual restriction to one host. Regarding the last point the authors are inclined to believe that the cane shoot borer is the main host of this parasite and records of its emergence from other borer hosts in the field are either doubtful or very infrequent.

The same authors<sup>16</sup> published observations on the biology of a very closely allied species, *S. deesae* Cam., occurring from March to September at Coimbatore. This species was found to attack the stem borers, *Diatraea stictieraspis* and *D. venosata* more than the shoot borer : in other respects it differed but little from *S. nicevillei*.

Yet another Braconid, *Rhaconotus scirpophagae* Wilk., parasitic on the cane shoot borer (*Scirpophaga nivella* in North India) was studied by Cherian and Israel<sup>17</sup> at Coimbatore. On an average, about 12 adult parasites were observed to emerge from each host larva and the total life cycle from egg to the emergence of adults took 24 to 41 days. In the field the attack by the parasite was noticed to be heaviest from June to April but was low in May and from October to December. The parasite is said to attack only one stage of its host caterpillar and lay eggs in clusters. Against these two drawbacks in its being an efficient controlling agent, it is long lived, has shorter life cycle than its host, a higher percentage of females than males and not known to attack any other host in the field. In view of all the three parasites, mentioned by the authors, and two of them almost exclusively, attacking the cane shoot borer, it should be interesting to know more definitely their relative incidence and their interaction upon one another in the field, since in any scheme of biological control it would be necessary to decide whether they should all be encouraged or only one to the exclusion of others.

Narayan<sup>18</sup> recorded *Stenobracon deesae* as having been bred from the root borers of sugarcane, *Emmalocera depressella* Swinh.,

---

16 Cherian, M. C. and Israel, P. (1938), *Madras Agric. Jour.*, **26**, 207.

17 Cherian, M. C. and Israel, P. (1938), *Ibid*, **26**, 127.

18 Narayanan, E. S. (1938), *Ind. Jour. Agric. Sci.*, **8**, 215.



at Pusa where the percentage of parasitisation in the field during 1935 and 1936 was observed to vary from 3 to 5.

Cherian and Basheer<sup>19</sup> published an account of the life history of the Chalcid, *Brachymeria excarinata* Gahan, recorded for the first time from South India, a pupal parasite of *Plutella maculipennis*. The parasite, which normally laid only one egg in each pupa, completed its life cycle in 10 to 15 days during September to December. It seemed to live fairly long, 140 days in case, and to be free from hyperparasites. In combination with another parasite, *Tetrastichus* sp., the authors consider it to be capable of reducing the pest.

Pruthi and Bhatia<sup>20</sup> recorded a Chamaemyid, *Leucopis griseola* Fall, for the first time from India. The larvae of this fly were observed predating on nymphs of *Aphis gossypi* Glover infesting cotton plants at Delhi. The flies appeared in November and December and oviposited among colonies of aphids. The young maggots fed voraciously on the aphid nymphs, many devouring 70 to 100 of the latter during their life. The authors, therefore, regard the fly as an effective enemy of the aphid pest of cotton. The maggots of the fly were also observed feeding upon *Macrosiphum granarium* (the barley and wheat aphid), *Myzus persicae* (infesting potato) and some unidentified aphids on hollyhock, *palak*, mustard, etc.

The controversy on the hosts of *Eupelmus tachardiae* How., between Mahdihassan on the one hand and workers at the Lac Research Institute, Namkum, on the other, reported in last year's Review, is enlivened by two contributions, one each from the upholders of the two view points. Negi and Gupta<sup>21</sup> have again maintained that *E. tachardiae* is endoparasitic on the female lac insect and ectoparasitic on the larvae of *Microbracon greeni* and other insects. In support of it they have published photomicrographs to demonstrate

1. Cocoon of *M. greeni* partly opened and fully opened showing a portion of *E. tachardiae* larva and the same taken out respectively.
2. Cluster of *M. greeni* cocoons showing larva of *E. tachardiae* in

19 Cherian, M. C. and Basheer, M. (1938), *Proc. Ind. Acad. Sci.*, **7B**, 289.

20 Pruthi, H. H. and Bhatia, H. L. (1938), *Ind. Jour. Agric. Sci.*, **8**, 735.

21 Negi, P. S. and Gupta, S. N. (1938), *Curr. Sci.*, **6**, 387.



one of them. 3. A female pupa of *E. tachardiae* in a nearly fully grown female lac cell partly opened. 4. Nearly fully grown female lac cell with a hole, 0.83 mm. in width, through which the female of *E. tachardiae* emerged and whose head width also measured 0.83 mm. It seems that in rare cases an *E. tachardiae* larva may after devouring *M. greeni* larva feed on other unparasitised larvae, if available, or even on the remains of larva of *Eublemma amabilis* which is contaminated with the smell of its (*E. tachardiae*) host, *M. greeni*. The authors suggested that Mahdihassan's observations, if correct, may possibly fall in the last category.

Mahdihassan<sup>22</sup> in his reply has held that the body of the lac insect is really too small to admit the possibility of *E. tachardiae* acting as its internal parasite. Nor can it be supposed that a large Chalcid pupa would lie curved, as alleged, in the body of its smaller host and develop into a smaller adult later on. Further no chalcid of his knowledge attacks only the adult lac insect and not its larva as seems to have been suggested by Gupta and Negi in the case of *E. tachardiae*. The author emphasises that the pupa of *E. tachardiae* was not seen by Negi and Gupta within the skin of the lac insect but merely inside a lac cell which may have harboured a larva of *Eublemma amabilis*, which, according to the author is the true host of *E. tachardiae*, and which, therefore, proves his point. Regarding the photomicrographs of *M. greeni* cocoons with *E. tachardiae*, the author thinks that it is impossible to identify any larva of the latter in them.

Krishnamurti<sup>23</sup> made a microscopical study of the famous Chalcid, *Trichogramma minuotum* Riley, egg parasite of sugarcane borers in Mysore. Several stages of the embryonic development of the parasite and its adults are illustrated, presumably, by photo-micrographs, but are merely mentioned in the text. What appears to be the main conclusion of the work, though hardly the result of microscopical study, namely, that other conditions being equal, greater parasite density (for egg laying) in a rearing cage does not produce greater output of parasitic adults, is interesting.

---

22 Mahdihassan, S. (1938), *Curr. Sci.*, **7**, 117.

23 Krishnamurti, B. (1938), *Proc. Ind. Acad. Sci.*, **7B**, 36.



## Taxonomy of Indian Insects.

The publication of the 'Catalogue of Indian Insects' was started in 1921, and up to date 23 parts have appeared in this series, including Part 23, dealing with Chalcidoidea by Mani<sup>24</sup> in 1938. Of the preceding parts, 8 dealt with groups of Coleoptera, 7 with Lepidoptera, 5 with Diptera and one each with Orthoptera and Hymenoptera. The Chalcidoidea are a big and important group consisting mostly of parasites and hyperparasites, and the collection of all the recorded Indian species with their original and references, synonymy, etc., should be of considerable use to economic workers. Altogether over 600 species are listed, assigned to 14 families, of which Agaonidae, Torymidae, and Eurytomidae contain many phytophagous species. In the introduction the author has given short diagnostic characters of the families together with the subfamilies into which they are divided, names of prominent workers on them and the number of their genera and species known from India. It speaks for the work done in India on parasites that in spite of an addendum of nine pages, the Catalogue is already in need of fresh additions.

Lal<sup>25</sup> published the first record of the Eulophid genus *Azotus* from India with the description of a new species, *Azotus de lhiensis*, reared from nymphs of the white fly, *Aleurolobus barodensis* Mask., infesting sugarcane at Karnal, Delhi. As two species of *Azotus*, out of about a dozen known so far, were suspected to be secondary parasites in America, the author thinks that this genus may turn out to be a mixed one from the economic stand point, containing both useful and injurious species.

Gardner has added two more studies to his old series on the "Immature stages of Indian Coleoptera". In the first<sup>26</sup> of these he has described and figured larvae of seven species of Carabidae, namely, *Omophorn smaragdus* And., *Harpalus Indicola* Bates, *Ophonus indicus* Bates, *Tachys umbrosus* Motsch., *Chlaenius*

---

24 Mani, M. S. (1938), Catalogue of Indian Insects, Part 23, Delhi.

25 Lal K. B. (1938), *Rec. Ind. Mus.*, 40, 1.

26 Gardener, J. C. M. (1938), *Ind. For. Rec., Ent. Ser.*, 3, 149.



*punctalostriatus* Chaud., *C. circumdatus* Brull., *Tetragonoderus elegans* Andr.

In the second paper<sup>27</sup> the larvae of 36 species of Curculionidae are described and figured and the larval characters of several sub-families are discussed.

The same author<sup>28</sup> also published a study on the larval characters of Lymantriidae under the general heading 'Immature stages of Indian Lepidoptera' to facilitate, the naming of species from larvae which often cannot be reared to adult stage yet have to be advised about in regard to their control etc. The paper gives keys and descriptions for the separation of nine genera, viz., *Lymantria*, *Dasychira*, *Orgyia*, *Laelia*, *Redoa*, *Stilphotia*, *Caviria*, *Perina* and *Euproctis*, and several of their species. The need for identifying species from larvae has been recognised from a long time and an early attempt in this direction was the publication of the 'Life Histories of Indian Insects' by Fletcher and others giving descriptions of the larvae of many Microlepidoptera and other groups of insects, together with notes on their hosts, distribution, etc. This series is still in progress at the Imperial Agricultural Research Institute, New Delhi.

Nixon<sup>29</sup> in a paper entitled 'Five new Asiatic Telenominae' describes a small brownish black new species, *Telenomus usipetes* from Burma, both sexes of this insect having been bred in January, February, May and September from eggs of *Hapalia machoeralis* Wlk. The same author in another paper<sup>30</sup> described a new genus *Nardo*, of the same sub-family, with type species *N. cumaeus* bred in September 1936 at Lyallpur from the eggs of the Hemipteron *Macropes excavatus* Distant, at times so abundant in Delhi and elsewhere under the leaf sheaths of sugarcane plants.

A new genus *Aivalykus* of the Braconid sub-family Hecabolinae was also described by Nixon,<sup>31</sup> with the type species *A. electus*

27 Gardner, J. C. M. (1938), *Ind. For. Rec, Ent. Ser.*, **3**, 277.

28 Gardner, J. C. M. (1938), *Ibid*, **3**, 187.

29 Nixon, G. E. J. (1938), *Ann. Mag. Nat. Hist.*, *Sr. II*, **1**, 584.

30 Nixon, G. E. J. (1938), *Ibid*, *Sr. II*, **1**, 278.

31 Nixon, G. E. J. (1938), *Proc. Roy. Ent. Soc. Lond.*, *B*, **7**, 152.



bred from wood of *Shorea robusta* and *Terminalia tomentosa* in various places in the United Provinces and Central Provinces. A new form, *A. electus* f. *simplex* is also recognised. Another new species described and referred to this genus, is *A. sperches* bred from wood of *Phoeb lanceolata* in the United Provinces. Unfortunately the hosts of the parasites seem to be unknown.

Takahashi<sup>32</sup> described a new Coccid, *Cryptoparlatoria pini* collected on leaves of *Pinus* sp. at Manali, Punjab and reported the occurrence of another Coccid, *Parlatoria pseudopyri* Kuwana in the Punjab, which was then only known from Hongkong.

A new Pyralid moth, *Noorda moringae*, bred from larvae of *Moringa* buds at Coimbatore was described by Tams<sup>33</sup>.

Munro<sup>34</sup> published systematic notes on a number of Trypetids collected in India and described four new species viz., *Chelyophora gladiella*, *Vidalia trigenata*, *V. fletcheri* and *Rhacochlaena cassiae*.

Mani<sup>35</sup> described a new genus and three new species of Cecidomyiade from the Pusa collection. *Rhabdophaga mangiferae* sp. n. bred from shoot galls of *Mangifera Indica* in South India and *Lobopteromyia prosopidis* sp. n. from galls on the rachides of *Prosopis spicigera* in Tanjore, are new records for their respective genera in India. *Anjeerodiplosis peshawarensis* (gen. n. & sp. n.) was bred from figs of *Ficus carica* and is now known to be a serious pest of cultivated figs in the North West Frontier Province.

The Indian species of the Hymenopterous genus *Xylocopa* Latr. were studied by Ma<sup>36</sup>. The paper contains descriptions of 5 new sub-genera, 5 new species and 2 new subspecies and also keys to Indian subgenera, species and subspecies.

Hafiz<sup>37</sup> described a new Chalcidoid, *Eupelmus terminaliae*, parasitising eggs of a Lasiocampid moth on the leaves of a country almond *Terminalia catappa*, and also recorded another Chalcidoid

32 Takahashi, R. (1938), *Proc. Roy. Ent. Soc. Lond.*, B. 7, 271.

33 Tams, W. H. T. (1938), *Bull. Ent. Res.*, 29, 9.

34 Munro, H. K. (1938), *Rec. Ind. Mus.*, 40, 21.

35 Mani, M. S. (1938), *Ibid*, 40, 331.

36 Ma, Tsing-Chao, (1938), *Ibid*, 40, 265.

37 Hafiz, H. A. (1938), *Ibid*, 40, 121.



*Brachymeria euploeae* (Westw.) having been bred as a larval parasite of the Lycaenid butterfly, *Virachola isocrates* F.

Singh<sup>38</sup> described 3 new species of Aleurodiae. The host of one of the species, *Aleuroputeus publicus* is mentioned as *Tephrosia purpurea*, a plant which holds some promise of its being used as an insecticide, and which grows commonly in Delhi and other places also in addition to Nagpur, the type locality.

Donisthorpe<sup>39</sup> described the solitary worker of a new species of a Myrmecine ant, *Aphænogaster* (*Attomyrma*) *cavernicola* taken in Naldera cave, Simla.

### Anti-insect resistance in plants.

Pruthi and Narayanan<sup>40</sup> studied the seasonal incidence of moth borers of sugarcane and the relative susceptibility of five varieties of cane, namely, Cos. 210, 213, 299, 313 & 331, to the attack of various borers at Pusa. Moths of these borers appeared in March in the field, laid eggs and the young borers hatching from them caused dead hearts to appear in April. The activity of all the borers was observed to increase with the advance of the season and the largest number of dead hearts were noticed during June or July. There was a lull during monsoon, followed by renewed activity in autumn when the top borer attack was found to be the heaviest. Regarding the susceptibility of the five varieties, the authors do not consider their results to be final but are inclined to think that on the whole Co. 299 and Co. 313 seem to be the most resistant, Co. 213 & Co. 210 the least resistant and Co. 331 coming in between these two groups.

### Miscellaneous.

Early in January Husain<sup>41</sup> delivered his presidential address to the Section of Entomology at the Silver Jubilee Session of the Indian Science Congress, on the past, present and future of Indian

---

38 Singh, (1938), *Rcc. Ind. Mus.*, **40**, 189.

39 Donisthorpe, H. (1938), *Ann. Mag. Nat. Hist.*, **2**, 498.

40 Pruthi, Hem Singh and Narayan, E. S. (1938), *Proc. Nat. Inst. Sci., India*, **4**, 87.

41 Husain, M. A. (1938), *Curr. Sci.*, **6**, 422.



entomology. The earliest beginnings of entomological science in India were coeval with ancient Sanskrit literature in which references to silkworm, honey bee and the lac insect abounded. Some insect pests were also dealt with in Atherva Veda. Entomology in modern India started mainly as the hobby of foreign amateurs who accumulated large insect collections and a vast body of information on their natural history. During the early part of the present century much work was done on the life history of insect pests. Vast as has been this progress there are still only about 4000 species, of insects known from India and according to a recent estimate, for every insect known there are 60 unknown in the country. Husain, therefore, concluded his address with a strong plea for the general recognition of entomology as an important and full fledged science in the Indian universities as well as elsewhere.

Pradhan<sup>42</sup> studied the mouth parts of the Coccinellid, *Coccinella septempunctata* and compared them with those of six other species, two herbivorous and four carnivorous. The differences in structure, between the herbivorous and carnivorous types of mouth offered interesting correlation with their feeding habits and were most noticeably, specially, in the mandibles.

Mukerji<sup>43</sup> studied the anatomy of the larval stages of the Bruchid beetles, *Bruchus quadrimaculatus* Fabr., and the method of emergence of the larva from the egg shell. The author discusses the views of previous workers on the latter and gives accounts of the mouth parts, salivary glands, alimentary canal, malpighian tubules, nervous and respiratory systems illustrated by photomicrographs of sections and by hand drawings.

Williams<sup>44</sup> published some records of butterfly migrations in India for the Himalayan and Northern India region, the area round about Kodaikanal in South India and several scattered localities in Southern and Western India with the exception of Panchamari in Central India which is also included. The list of migrant butterflies given by the author includes 32 species distributed in 6 families

---

42 Pradhan, S. (1938), *Rec. Ind. Mus.*, **40**, 341.

43 Mukerji, D. D. (1938), *Zeit. fur Angewandte Entomologie*, **25**, 442.

44 Williams, C. B. (1938), *Jour. Bom. Nat. Hist. Soc.*, **40**, 439.



excluding three species of *Papilio* mentioned at the end of the paper and several others belonging to a large number of families not hitherto recorded. Twenty species in the list and four in those of the hitherto unrecorded species are mentioned as also migrating in Ceylon. The question of insect migration is not as academic as it looks at first sight. Several migrant butterflies are pests, e.g., *Pieris brassicæ*, and their movements should be of interest to those entrusted with the protection of crops. One would readily agree with the author that the need of the moment is to have trained observers in India who would correctly record genuine cases of migration. Such data will yield interesting results if correlated with known facts of insect life history.



## XII. ANIMAL NUTRITION AND DAIRYING

By A. V. Iyer.

### 1. Animal Nutrition.

Makhijani and Banerjee<sup>1</sup> have performed certain feeding trials to increase the vitamin and carotene content in milk and butter fat of dairy cows. They have estimated the carotene content of 125 fodders (roughages and concentrates). They say, that from a feeding trial for a short period, it is not possible to deduce any definite conclusions. In a trial on lactating cows it is not possible to measure the vitamin A reserve before or after the experiment. The stored up vitamin A is so slowly used up when carotene supply is in deficit that no detectable difference can be noted in milk. However, the yellow value in butter and the carotene content of blood go to show that increased carotenoid feeding helps to build up a reserve of vitamin A in the animal and causes a slight increase in the milk supply.

Iyer and Ayyar<sup>2</sup> have conducted an experiment on the mineral assimilation of growing calves. Eight bull calves, 14 to 17 months old, were selected and divided into two similar groups of four each. One group received the basal ration which consisted of hay, *Guinea* grass (green), wheat bran and ground-nut cake and the other group, in addition to the basal ration a supplement of 30 grams of calcium phosphate. Three digestion and mineral balance experiments were carried out. After 17 weeks of feeding, the groups were reversed : the animals receiving the basal ration now got the mineral supplement.

The digestibility figures indicate (1) that even with the larger intake of phosphoric acid there has not been any change in the digestibility of protein, and (2) that when the minerals are sufficient

---

1 Makhijani, J. K. and Banerjee, B. N. (1938), *Ind. J. Vet. Sci., and Anim. Husb.*, **8**, 13.

2 Iyer, A. V. and Ayyar, N. K. (1938), *Ibid*, **8**, 43.



in the feed itself, a supplement of calcium phosphate does not show any visible effect, except for the fact that the animals receiving the supplement retain more calcium and phosphorus in their systems.

Sen and Seshan<sup>3</sup> have summarised the present position of avitaminosis—A so far as it relates to the feeding of farm animals. Cereals, grain feeds, vegetable oils and oil cakes are poor sources of carotene (the precursor of vitamin-A) which is generally associated with the pigments of plant material. Green young forage plants are, however, found to be satisfactory sources of carotene for animals and they have laid stress on the provision of suitable green feeds or pasture land as the only practical method of supplying the carotene requirement of farm animals. The importance of preserving the vitamin-A potency of green plants while they are being converted into hay or silage, is also emphasised.

Chatterjee and Hye<sup>4</sup> have conducted feeding and digestion tests to ascertain the value of *Aus* paddy straw and compared the same with that of *Aman* paddy straw. From the analytical and experimental figures, the authors have concluded that (1) weight for weight, *Aus* straw is a better fodder than *Aman* straw; (2) both types of straw by themselves are unable to maintain an animal, but *Aus* straw being richer in protein and minerals requires less of concentrate for maintenance.

Carbery and Chatterjee<sup>5</sup> have studied the effect of rice *Kura* (bran) as concentrate feed, with rice straw as roughage. Their experimental figures indicated that though the energy supply was good the animals fared badly. This is attributed to the highly imbalanced nature of the mineral constituents. The feed is very rich in  $P_2O_5$  but is very low in lime content. Chlorine content is also below requirement.

---

3 Sen, K. C. and Seshan, P. A. (1938), *Ind. J. Vet. Sci., and Anim. Husband.* **8**, 169.

4 Chatterjee, I. and Hye, M. A. (1938), *Agri. and Live-stock in India*, **8**, 361.

5 Carbery, M. and Chatterjee, I. (1938), *Ibid*, **8**, 367.



Sen and Seshan<sup>6</sup> have discussed the problem of animal nutrition in India and have given figures for the available feed to the animal which is only 50 per cent higher than what is required for maintenance. The requirements for milk production and work have to be found from this slight excess, because the general feeding of concentrates by the village cultivator is practically nil. Generally, the feed available is poor in quality; hence the animals cannot obtain all their requirements, particularly as regards protein and some mineral ingredients. This inadequacy has resulted in the inefficiency of the Indian animals as compared with those of other countries.

Chatterjee and Hye<sup>7</sup> discuss the possibility of the utilisation of water-hyacinth as a cattle feed. From the experimental data, it may be gathered that the animals do not take kindly to water-hyacinth. Its feeding value is as good as *Guinea* grass or *Napier* grass, but its palatability is poor because of the high potash and chlorine content. As consumption of dry matter is low with water-hyacinth-paddystraw animals, all lost weight and condition. Water-hyacinth-cake animals fared much better. This clearly indicates that water-hyacinth-straw combination is not a sufficient maintenance ration.

A study of the lime and phosphorous requirement was undertaken by Chatterjee and Talapatra<sup>8</sup> with Bengal cattle. The ration consisted of *Aman* or *Aus* paddy straw with a small supplement of oil cake. The authors have come to the conclusion that the lime requirement under rice straw feeding appears to be higher than that under other feeds. The mineral requirements are 24 grams lime and 10 grams  $P_2O_5$  for an animal of 500lb. live weight. In the assimilation of these ingredients the nature of the feed is the chief determining factor,

---

6 Sen, K. C. and Seshan, P. A. (1938), *Agri. and Live Stock in India*, 8, 524.

7 Chatterjee, I. and Hye, Md. A. (1938), *Ibid*, 8, 547.

8 Chatterjee, and Land Talapatra, S. K. (1938), *Ibid*, 8, 559.



## 2. Dairying.

Sivasubramanian and Dover<sup>9</sup> have made a study of the colostrum of the dairy cow and the dairy buffalo. After detailing the method of sampling and analysis, the authors made a study of globulins, particularly because this protein is responsible for the transmission of maternal antibodies to the young. Except in regard to fat content, the results follow about the same order in all the cases. Buffalo's colostrum is higher in specific gravity, acidity, sodium chloride, total solids, total proteins, casein, albumin, globulin and ash than cow's colostrum, while in lactose, it is lower. Globulin constitutes the major part of the total protein of the colostrum soon after calving and its decrease is more marked during the first 24 hours than during the remainder of colostral period. Buffalo's colostrum changes to normal milk in about three days while that of the cow takes four days.

Loss of fat in butter making and prevention of same was studied by Francisco<sup>10</sup>. After giving the experimental details he has arrived at the following conclusions :—(1) When the concentration of fat is maintained at 30 per cent, the loss of fat in the butter milk is at its minimum. (2) The optimum temperature of ageing is 48–52° F. and that of churning the cream 54–56°F. (3) Citric acid and sodium citrate reduce the loss of fat in the butter milk to a minimum, when cream with 30 per cent fat is churned, the loss being 0.1 per cent as compared with the control where it is 0.15 per cent. The addition of citric acid and sodium citrate improves the aroma, flavour and keeping quality of the butter.

Manufacture of casein under Indian conditions was studied by Annaswamy and Paul<sup>11</sup>. They made three types of casein

---

9 Sivasubramanian, V. and Dover, C. W. (1938), *Ind. J. Vet. Sci., and Anim. Husb.* **8**, 29.

10 Francisco, J. S. (1938), *Agri. and Live Stock in India*, **8**, 262.

11 Annaswamy, S. and Paul, D. L. (1938), *Ibid.*, **8**, 942.



(1) Rennet Casein; (2) Lactic Casein and (3) Acid casein. One outstanding feature in the composition of these three types of casein is the high ash content in the Rennet casein. This type of casein also gives the best glue the binding capacity of which is nearly three times as much as that of the other two types. Acid casein gives the best yield.



### XIII. HUMAN PHYSIOLOGY

By N. M. Basu.

I have been helped materially in preparing this short review by three of my colleagues and ex-students, viz., Dr. B. Chatterjee, Mr. D. N. Mallick and Mr. G. K. Roy. I take the opportunity of thanking them profusely. The various investigations may be classified under the following heads :—

#### 1. Blood and Cardio-vascular System.

Napier<sup>1</sup> has shown that there is no great difference in the Hb or cellular content of the blood in Europe and India, but rather the Hb is higher in India. The blood-picture of normal coolies in tea-gardens shows that the mean Hb is much lower than that of the city-dwelling Indians, though the number of r. b. c. is about the same.

Sankaran<sup>2</sup> has shown that there is no relation between the weight and Hb content of the blood of persons. He has also determined<sup>3</sup> the mean cell-diameter of 25 South Indians by a modified area method and has found that the mean cell-diameter is 6.85 microns with a coefficient of variation of 4.17. (The mean cell-diam. of Europeans, according to Price-Jones is 7.202 microns). He<sup>4</sup> further found that the average Hb-content of 20 male Indians at Coonoor (6000 ft. above the sea-level) is 16.45 g. per 100 c.c. (determined with Van Slyke's apparatus) as against 15.85g. for English males (by Don & Jenkins), or 14.75g. for the same (by Price Jones *et al*), and 14.77g. for Bengalees (by Napier). This high Hb content is accounted for by the altitude factor at Coonoor.

Sokhey *et al*<sup>5</sup> have found that the average Hb-contents of blood of men and women in Bombay and the U. S. A. determined by

---

1 Napier, E. (1938), *Proc. 25th Ind. Sci. Cong.*, Part 3, p. 281.

2 Sankaran, G. (1938), *Ibid*, Part 3, p. 281.

3 Sankaran, G. (1938), *Ind. Jour. Med. Res.*, **25**, 951.

4 Sankaran, G. (1938), *Proc. 25th Ind. Sci. Cong.*, Part 3, p. 283.

5 Sokhey, S. S. *et al* (1938), *Ibid*, p. 282.



the same method, viz., Van Slyke's  $O_2$ -capacity method, tally closely, e.g., 15, 37g. per 100 cc. of blood for men and 12.99g. for women in both places. They<sup>6</sup> have further determined the following standards of blood for women after a study of 101 healthy young women of Bombay (ages 16-30):—(R. B. C.—4.47 millions per c. m.m, (2) Hb. in g. per 100 cc—12.99, (3) Cell-volume in c.c. per 100 c.c.—36.27, (4) Hb-coefficient in g. per 100 c.c.—14.55, (5) volume-coefficient in c.c. per 100 c.c.—40.61, (6) colour-index—1.00, (7) volume-index—1.00 and (8) Saturation-index—100.

Sankaran<sup>7</sup> has found, after examining the blood of 125 healthy, young South Indian males and 62 healthy, young South Indian women, that the Hb value in the former is 16.57 per 100 c.c. of blood, with a coefficient of variation of 6.7%. He<sup>8</sup> further studied the rise in Hb percentage in a group of British soldiers during their stay at Coonoor and noticed that while their mean initial Hb-content was 12.84g%, it rose by 6.72g% in the course of 3 weeks' stay, but, curiously enough, no further significant rise took place with the prolongation of their stay.

Rao<sup>9</sup> studied the mean Hb values of 100 pregnant and 100 non-pregnant women at Coonoor and found that they were 15.52g. and 15.81g. per 100 c.c. of blood respectively. No correlation existed between Hb and age, parity and duration of pregnancy.

Sankaran<sup>10</sup> further observed that the daily administration of 6 grs. in two doses of 3 grs., of  $FeSO_4$  or Ferri-et-ammon citras to girls and young women during menstruation and in the intermenstrual period for 4 to 6 weeks caused a rise in Hb from the initial level of 16.35g.% to 20.34g.% in one school and from 13.69g. to 18.44g.% in another school. No difference was found in Hb content of the blood of girls who had and had not attained puberty, or of girls during menstruation and in the intermenstrual period.

---

6 Sokhey, S. S. *et al* (1938), *Ind. J. Med. Res.*, **25**, 723.

7 Sankaran, G. *et al* (1938), *Ibid*, **25**, 741.

8 Sankaran, G. *et al* (1938), *Ibid*, **25**, 971.

9 Rao, M. V. R. (1938), *Ibid*, **25**, 957.

10 Sankaran, G. (1938), *Ibid*, **25**, 753.



The Hb content returned to the 'pre-Fe level' two months after the administration had ceased.

Cropper<sup>11</sup> *et al* found that the average Hb content of adult Burmese males is 15.6g% and of adult Burmese females 13.7g%.

Napier<sup>12</sup> described the technique of Sternum puncture and found the following in sinusoidal blood: viz., (a) Hb 1.—5g. less than that of venous blood, (b) R.B.C.— $\frac{1}{2}$  a million less, (c) Reticulocytes—the same percentage as that in peripheral blood, (d) Megaloblasts or cells similar to them are present.

Dharmendra<sup>13</sup> has shown that the Arneth counts of fifty apparently healthy Indians show a left handed shift as compared to the standard in Britain. He believes that the shift is not due to any latent or active infection but to some environmental factor or factors prevalent in tropical or sub-tropical countries, for a similar shift is also noticed in the Iraqis and the Chinese.

Rahman *et al*<sup>14</sup> have shown that the total white cell count of 88 healthy men at Hyderabad (Deccan) varies between 4000 to 13,100, the average being 7128 and the average of the polynuclear count is 2442.

Mukherjee<sup>15</sup> has shown that phagocytosis of carbon particles increases with the diminution of the negative charge of these particles and becomes maximal near about their neutral point.

Bose *et al*<sup>16</sup> have shown that ayapanin and ayapin have great possibilities as haemo-statics.

Burridge<sup>17</sup> *et al* have shown that choline acts as a cardiac depressant between dilutions  $10^{-2}$  to  $10^{-8}$  when the heart is perfused with a solution containing too little Ca to maintain its activity for more than  $\frac{1}{2}$  an hour. At higher dilutions choline has no action. After the washing off of choline, the cholinised heart not only

11 Cropper, (1938), *Ind. Med. Gaz.*, **73**, 139.

12 Napier, L. E. (1938), *Ibid*, **73**, 1.

13 Dharmendra, (1938), *Proc. 25th Ind. Sci. Cong.* part, 3, p. 282.

14 Rahman, S. A. *et al*, (1938), *Ibid*, part 3, p. 283.

15 Mukherjee, S. N. (1938), *Ibid*, part 3, p. 279.

16 Bose, P. K. *et al*, (1938), *Ibid*, part 3, p. 232.

17 Burridge, W. *et al*, (1938), *Ibid*, part 3, p. 280.



recovers completely from the depressant effects but also shows an indefinite prolongation of activity.

Basu *et al*<sup>18</sup> have shown (1) that the addition of adrenalin to the perfusion fluid, deficient in Ca, prevents the stoppage of heart-beat, but this maintenance-capacity of adrenalin is not noticed when the perfusion fluid contains an excess of Ca; (2) that in the absence of Ca in the perfusion fluid the stimulating action of acetyl-choline on the heart is very prominent, but it diminishes gradually with the addition of Ca in increasing amounts to the perfusion fluid; in the absence of K the action of acetyl choline is not much evident; (3) that the stimulation of the vagus by a very weak and rapidly intermittent current slows and weakens the heart beat, if the heart be perfused with Ca-free Ringer, but this effect is not noticed as soon as Ca is added to the perfusion fluid even in subnormal amounts; and (4) that in K-free Ringer, adrenaline augments the heart-beat but makes the heart stiff, whereas after the addition of K to the same perfusion-fluid even in small and subnormal amounts the stimulation effect of adrenalin is less marked and the stiffness of the heart muscle is not noticed.

Basu *et-al*<sup>19</sup> have shown by vessel perfusion methods that whereas adrenalin causes immediate and temporary vaso-constriction, phloridzin produces a delayed but more lasting effect. The vasodilator effect of histamine is immediate and temporary. Cobra venom has no effect on the tone of blood vessels.

Narayana<sup>20</sup> has shown that the action of adrenalin on blood vessels is not modified in any way by previous perfusion with ergotamine.

Roy<sup>21</sup> has shown that Seitz filtration removes the haemolytic property of dilute solutions of saponins and also the bacterial haemolysins (of cholera and streptococcus) and inactivates diluted guinea-pig complement and anti-sheep amboceptor. This process

---

18 Basu, N. M. *et al*, (1938), *Proc. 25th Ind, Sci. Cong.*, part 3, p. 286.

19 Basu, N. M. *et al*, (1938), *Ibid*, part 3, p. 286.

20 Narayana, B. (1938), *Ibid*, part 3, p. 285.

21 Roy, A. C. (1938), *Ibid*, part 3, p. 238.



of filtration does not affect so much concentrated solutions of active substances.

## 2. Enzymes, Alimentation and Metabolism.

Mahal<sup>22</sup> has shown that although choline-esterase activity of blood or serum varies in different animals and individuals, it is constant in the same individual over long periods, is identical in venous and arterial blood and serum and is unaffected by refrigeration, sleeplessness, change in environment, fasting, glucose-feeding and subcutaneous injection of various drugs.

Napier *et al*<sup>23</sup> found by a series of fractional gastric analyses with alcohol test meal on 209 hospital patients, not suffering from gastro-intestinal diseases, that the Europeans had the highest mean acidity, then the Bengalees, and after them the other Indians, of whom the majority were Punjabees, although the Bengalee group included the largest percentage of vegetarians.

Ghosh<sup>24</sup> *et al* have shown that the alcohol test meal gives slightly higher figures for acidity than an oatmeal gruel meal in Bengalees and that figures for acidity obtained with alcohol test meal in Bengalees are very similar to those found for Europeans.

Pasricha *et al*<sup>25</sup>, after examining 562 samples of fæces from 214 persons concluded that (a) the faecal reaction of breast-fed babies is acid, but those on cow's milk is alkaline, (b) the reaction of Europeans and non-Indians on European diet is generally alkaline, (c) the reaction of Indians on mixed Bengalee diet, including rice, is acid but of Marwaris with vegetarian diet without rice is alkaline and (d) that replacement of rice from mixed Bengalee diet by bread, changes the reaction from acid to alkaline in some cases.

Sharma<sup>26</sup> has shown, from a large number of glucose tolerance tests in elderly people, that (1) in old age the renal threshold for glucose is raised, and (2) the storage defect is common.

---

22 Mahal, H. S. (1938), *Ind. J. Med. Res.*, **25**, 703.

23 Napier, L. E. *et al.* (1938), *Ind. Med. Gaz.*, **73**, 65.

24 Ghosh, J. *et al.* (1938), *Cal. Med. J.*, **33**, 45.

25 Pasricha, C. L. *et al.* (1938), *Ind. Med. Gaz.*, **73**, 141.

26 Sharma, (1938), *J. Ind. Med. Ass.*, Sept.—'38, p. 641.



Srikantia *et al*<sup>27</sup> found that (1) the fasting blood sugar of 71 children, between 1½ yrs. and 4 yrs. of age, had an average value of 74 mg. % ; (2) the blood sugar of 107 male students of Mysore, who had previously fasted for 12 hrs. varied between 67 and 118 mg. %, (c) the fasting blood sugar of 7 South Indian women students varied between 79—90 mg. % and that 4½ hrs. after food, it varied between 80—93 mg. %, but at the onset of menstruation there was a rise followed by a fall in blood-sugar.

Chakravarti<sup>28</sup> in studying Van den Bergh's tests in various cases of jaundice noticed that (1) bile salts play a very important role in the di-azo-colour phenomena, for the addition of a little bile-salts brings about a prompt direct reaction in a low concentration of bilirubin which would either give a delayed direct reaction or even negative results ; and (2) that the biphasic type of reaction is caused by the presence of a small amount of Hb along with bile-salts and bilirubin.

Wilson and Roy<sup>29</sup> after studying the B. M. R. of 62 boys between 6 and 16 yrs. have found that the figures are lower than those of Aub and Du-Bois, or Boothby and Sandford but somewhat higher than those of Benedict.

Ahmad *et al*<sup>30</sup> have shown, by studying the B. M. R. of 9 healthy Indians, that the B. M. R. in each subject in outside atmosphere during monsoon is lower than that of the American standards and that it is still lower when the persons go over to the air-conditioned rooms, although individuals vary in their response to such sudden changes in temperature.

Rajagopal<sup>31</sup> has found that the B. M. R. of Indians is 8% lower than that of Europeans at Conoor, 6,000 ft. above the sea-level.

Rahman<sup>32</sup> after studying the B. M. R. on a single subject for 31 days from Aug. to Sept. 1937, at Hyderabad (Deccan) has

---

27 Srikantia, C. *et al*, (1938), *Proc. Ind. Acad. Sci.*, **7B**, 225, 230, 235.

28 Chakravarti, A. R. (1938), *Proc. 25th Ind. Sci. Cong.*, part 3, p. 245.

29 Wilson, H. E. C. *et al*, (1938), *Ind. J. Med. Res.*, **25**, 901.

30 Ahmad, B. *et al*, (1938), *Proc. 25th Ind. Sci. Cong.*, part 3, p. 278.

31 Rajagopal, K. (1938), *Ind. J. Med. Res.*, **26**, 411.

32 Rahman, S. A. (1938), *Ibid*, **26**, 411.



noticed that there is no marked difference in results during winter and summer, the results in summer being slightly higher than during winter. During July, when rains set in, the B. M. R. was slightly lower than during May and June. The average B. M. R. for the 31 days was 12.1% below Harris-Benedict and 18.3% below Aub-Du-Bois standards.

De and Bhattacharyya<sup>33</sup> have found (1) that in normal drawn oxalated blood, glycolysis takes place at a rate of 3.83mg. to 6.50 mg. (total range 2mg. to 11 mg.) per hour per 100 cc. of blood, giving an average rate of 5.56 mg. per hour, the calculated average velocity percentile glycolysis being 6.05 mg. % per hour, (2) that in diabetic blood glycolysis proceeds at a rate of 4 mg. to 16.6 mg. % per hour (total range 0 mg. to 36 mg. per hour) giving an average rate of 11.06 mg. per hour; the calculated average velocity of percentile glycolysis in diabetic blood being 4.61 mg. per hour per 100 cc. of blood and (3) that the average velocity of percentile glycolysis in diabetic blood per hour is therefore, found to be less by 1.44 mg. (6.05 mg—4.61 mg.), showing a depression of about 23.8% from normal blood.

De and Bhattacharyya<sup>34</sup> have further shown (1) that complete glycolysis does not take place after 24 hours incubation in oxalated blood; (2) that the percentage of sugar glycolysed in 24 hours is found to bear a more or less inverse ratio to the initial sugar concentration up to 280 mg. per 100 cc. of blood; (3) that the accumulation of lactic acid in blood possibly prevents further glycolysis in later periods; and (4) that the amount of non-glucose Cu-reducing substances in blood is found to be about 6 mg. to 8 mg. per 100 cc. of blood.

### 3. Biochemistry.

Basu<sup>35</sup> and Mitra have shown that the great difference in osmotic pressure between the yolk and white of egg, in spite of the

---

33 De, P. and Bhattacharyya, S. (1938), *Ind. J. Med. Res.*, **25**, 924.

34 De, P. and Bhattacharyya, S. (1938), *Ibid*, **25**, 933.

35 Basu, N. M. and Mitra, M. C. (1938), *Proc. 25th Ind. Sci. Cong.*, part 3, p. 280.



permeable vitellin membrane separating them, is maintained not by the Donnan membrane equilibrium, but by the vital activity of the membrane, for injection of a very small dose of NaF, which kills the activity of living cells, into the white causes the disappearance of this difference in osmotic pressure.

Chopra and Roy<sup>36</sup> have given figures for the different constituents present in the sweat of normal persons living in and around Calcutta.

Roy<sup>37</sup> having examined a large number of normal urines collected over a period of 24 hours, concluded that total N, urea, inorganic sulphate and Ca excretions are greatly lower, chloride excretion is definitely higher and creatinine, uric acid, ethereal and neutral sulphate and inorganic phosphate outputs are more or less the same as those for European or American subjects on ordinary mixed diets.

Chatterjee and Basu<sup>38</sup> have shown that in idiopathic (i. e., pernicious) anaemia of pregnancy four stages can be distinguished and the treatment is different in these stages.

Chakravarti and Tyagi<sup>39</sup> in studying the effects of heat on the human body noticed the following changes:—(1) tendency towards retention of nitrogenous constituents in the blood, (ii) increased blood creatinine and inorganic phosphates, (iii) low blood—Ca; (ii) and (iii) suggested kidney insufficiency which was confirmed by the presence of albumin, casts, etc.; (iv) low chloride content in blood and urine; (v) increase in blood lactic acid and other anions; (vi) increase in viscosity and specific gravity; (vii) low surface tension; and (viii) low specific conductivity.

Bhagvat<sup>40</sup> has shown that the estimation of adrenaline by an oxidase, extracted from the seeds of *Dolichos lablab*, gives results which agree well with those given by biological methods, but the chemical method gives variable results.

---

36 Chopra, R. N. and Roy, A. C. (1938), *Proc. 25th Ind. Sci. Cong.*, part 3, p. 277.

37 Roy, S. N. (1938), *Ibid*, part 3, p. 279.

38 Chatterjee, H. N. and Basu, C. (1938), *J. Ind. Med. Ass.*, 8, 1.

39 Chakravarty, D. N. and Tyagi, N. (1938), *Ind. J. Med. Res.*, 25, 791.

40 Bhagavat, K. (1938), *Ibid*, 25, 911.



De and Chatterjee<sup>41</sup> have shown that the formalin method of estimation of  $\text{NH}_2$  in body fluids can be used as a substitute for the process of nesslerization in general and has many advantages over the latter method.

Mukherjee and Guha<sup>42</sup> have shown that choline feeding cannot prevent the acute increase of liver fat caused by a single large dose of anterior pituitary extract, although it brings about a change in the iodine number of fatty acids. Best *et al* showed that anterior pituitary extract causes a considerable deposition of fat in liver of rats and that choline feeding prevents deposition of fat in liver.

#### 4. Experimental Physiology and Histology.

Basu and Mukherjee<sup>43</sup> have shown by repeated stimulation of a muscle by a Neon-lamp stimulation system :—(1) that adrenalin or  $\text{CaCl}_2$  in subnormal amounts strengthens the contractions and hastens fatigue and the addition of both has a summation effect, i. e., more increase in contractions and greater hastening of fatigue; (2) that the addition of  $\text{CaCl}_2$  in greater concentrations causes a further increase in contractions but delays fatigue and these effects are augmented by the addition of adrenalin; (3) that if the concentration of Ca in the fluid be very high, viz., 5 times the amount present in Ringer, the augmented contractions and delayed fatigue are still obtained, but the addition of adrenalin at this stage quickens the onset of fatigue and (4) that the addition of KCl to O.KR (ie., K-free Ringer) quickens the onset of fatigue and the addition of acetyl choline to it helps relaxation and delays the onset of fatigue.

Ghaffar<sup>44</sup> has shown by studying the exchange of dissolved substances between a voluntary muscle and saline solutions that the muscle water may be divided into inter-space water and cell water, the former about  $\frac{1}{3}$  and the latter about  $\frac{2}{3}$  of the total

---

41 De, P. and Chatterjee, C. C. (1938), *Ind. Jour. Med. Res.*, **25**, 915.

42 Mukherjee, B. and Guha, R. C. (1938), *Ibid*, **26**, 295.

43 Basu, N. M. and Mukherjee, G. G. (1938), *Proc. 25th Ind. Sci. Cong.*, part 3, p. 285.

44 Ghaffar, A. (1938), *Ibid*, p. 290.



cell water, and that certain substances, such as urea, histidine and  $\text{CO}_2$ , can diffuse through the whole of muscle water and certain substances, such as, lactate, iodide, chloride, bi-carbonate, etc., can diffuse through interspace water only.

Chopra and Das<sup>45</sup> have shown:—(1) that lowering of temperature reduces the potential and frequency of brain impulses from an anaesthetised animal, but makes them steady and uniform; and (2) that raising the temperature increases the potential and frequency of these impulses but they are not uniform and show marked fluctuations in both amplitude and intensity.

Rao<sup>46</sup> has shown that the polarized light technique of Sutton *et al* for following the progress of myelin degeneration in a nerve after transection, is simple, rapid and reliable.

---

45 Chopra, R. N. and Das, N. N. (1938), *Proc. 25th Ind. Sci. Cong.*, part 3, p. 277.

46 Rao, M. V. R. (1938), *Ind. J. Med. Res.*, **26**, 103.



## Index of Authors

	PAGE.		PAGE.
<b>A</b>		<b>B—Contd.</b>	
Acharya, C. N.	81, 90, 92, 98	Bhagvat, K.	1, 15, 18, 152
Achuthan, A.	25	Bhaskaran, T. R.	62, 97
Adler, E.	13, 14	Bhatia, G. S.	110
Agarwal, R. R.	7	Bhatia, H. L.	132
Ahmad, B.	28, 45, 46, 47, 156	Bhatnagar, S. S.	38
Ahmad, N.	79	Bhattacharji, S.	29
Ahmad, T.	126	Bhattacharya, S. N.	105
Ahuja, M. L.	34	Bhattacharyya, S.	151
Aiyar, A. V.	49	Bhavani, G. P.	78
Aiyar, N. K.	49	Billimoria, H. S.	19
Ali, P. M.	39	Biswas, C. N.	29
Anantanarayan, K. P.	128	Biswas, M. M.	32
Anantanarayanan, P.	8, 56	Biswas, S. C.	59
Annamali	23	Bose, H. N.	37
Annaswamy, S.	52, 143	Bose, N. M.	90
Asgar, A. G.	83, 86, 91	Bose, P. K.	104, 105, 107, 147
Aykroyd, W. R.	45, 46, 48	Bose, R. D.	112
Ayyar, N. K.	140	Bose, S. K.	37
Ayyar, T. V. R.	129	Bose, S. R.	119, 121
<b>B</b>		Brahmachari, K.	129
Bal, D. V.	61	Brockmann, H.	106
Bamji, N. S.	89	Burridge, W.	147
Banerjee, B. N.	43, 44, 50, 140	Buxton, P. A.	38
Banerjee, G. G.	5	<b>C</b>	
Banerji, B. N.	67	Carpenter, P. H.	96
Banerji, S. M.	18	Chakraborty, J. N.	84
Basak, M. N.	57	Chakravarti, A. R.	150
Basheer, M.	132, 137	Chakravarti, J.	13
Basu, C.	152	Chakravarty, D. N.	31, 152
Basu, J. K.	81	Chakravarty, M.	2
Basu, K. P.	42, 54, 56, 57	Chakravarty, P. N.	102, 104
Basu, N. M.	4, 5, 59, 145, 148, 151, 153	Chakravarti, S. C.	75, 78
Basu, P. N.	32	Chakravarty, S.	85
Basu, U. P.	4, 41	Chatterjee, C. C.	153
Batra, H. N.	128	Chatterjee, I.	141, 142
Bedi, K. S.	111	Chatterjee, N. R.	17, 104
Bhaduri, B. N.	29	Chatterji, B. C.	35
		Chatterji, D. N.	26, 34



	PAGE.		PAGE.
<b>C—Contd.</b>		<b>D—Contd.</b>	
Chatterji, H. N.	22, 26, 152	De, S. P.	4
Chatterji, N. C.	98, 130	De, P. K.	59, 90, 94
Chatterji, R. G.	3	De Monte, A. J. A.	35
Chatterji, S. K.	33	Desai, L. N.	91
Chatterji, U. N.	66	Desai, S. V.	60, 89
Cherian, M. C.	127, 128, 131, 132	Deshapande, S. S.	100
Chaudhuri, M. N. R.	51	Deo, L. R. S.	32, 33
Chaudhury, R. N.	21, 22, 23, 25, 51	Dey, A. C.	23
Chopra, R. N.	2, 3, 4, 10, 17, 31, 100, 102, 103, 104, 152, 154	Dey, B. B.	103
Choudhri, R. S.	74, 76	Dey, N. C.	31
Choudhury, S.	48	Dhar, B. K. L.	77
Chowdhuri, H.	120	Dhar, N. R.	61
Chima, I. S.	65, 73	Dharmendra	36, 147
Chiney, S. S.	97	Dikshit, B. B.	1
Chitre, R. G.	50	Doctor, N. S.	43, 49
Chona, B. L.	116	Donisthorpe, H.	137
Clinton, G. P.	123	Dover, C. W.	42, 143
Cruickshank, M. M.	23, 30	Dua, A. N.	82
Cropper, C. F. J.	21, 147	Dutt, S.	99, 100, 103, 105, 109
Carbery, M.	141	Dutta, A. T.	3, 100, 102, 104
Cowlogi, S. S.	44	<b>E</b>	
Crowther, F.	78	Eden, T.	96, 97
<b>D</b>		Euler, H. Van	13, 14
Dabral, B. M.	97	<b>F</b>	
Damodaran, M.	8, 14, 56, 105	Fazaluddin	60, 89
Das, B. C.	27, 32, 33	Francisco, J. S.	51, 143
Das, K.	97	<b>G</b>	
Das, N. B.	13, 14	Ganapathi, C. V.	9, 10, 14, 18, 108, 109
Das, N. N.	2, 154	Ganguli, P. M.	64
Das, P. C.	34, 35	Ganguly, R.	47
Das-Gupta, B. M.	4, 27, 38	Gardner, J. C. M.	134, 135
Das-Gupta, P.	40	Gare, H. K.	45
Das-Gupta, S. N.	119	Ghaffair, A.	153
Dastur, R. H.	68, 69, 70	Ghani, M. A.	110
Datta-Roy, B. K.	32	Ghatak, P. N.	115
Datta, N. C.	50	Ghosh, B.	15
De, A. C.	23	Ghosh, H.	37
De, H. N.	42, 54, 56	Ghosh, J.	51, 149
De, M. N.	22, 25	Ghosh, J. L.	23
De, M. N. B.	27	Ghosh, N. N.	100, 103
De, N.	3	Ghosh, S.	3, 17, 92, 100, 102, 104
De, N. K.	41, 43, 50		
De, P.	29, 151, 153		



	PAGE.		PAGE.
<b>G—Contd.</b>		<b>J</b>	
Ghosh, S. M.	22, 32	Jain, D. N.	7
Ghosh, T. K.	31	Johan, W.	70
Ghoshal, S. C.	35	Joshi, N. V.	59, 60
Giri, K. V.	6, 7, 11, 13, 17, 29, 41, 49	<b>K</b>	
Gokhale, S. K.	19	Kahali, B. S.	21
Gollerkeri, P. G.	30	Kaikini, V. M.	24
Goswami, H.	41	Kamat, M. N.	112, 113, 114, 118
Gorrie, R. M.	86, 87	Kanitkar, N. K.	69
Goyal, R. K.	36, 37, 51	Kanna, K. L.	65
Grassman, J.	108	Kapoor, G. P.	76, 78
Greval, S. D. S.	27	Kelu, M.	25
Grewal, K. S.	43	Kesavaswamy	30
Guggenheim, T.	105	Kini, M. G.	30
Guha, B. C.	15, 49	Klan, M. H.	126
Guha, R. C.	2, 153	Kochhar, B. D.	43
Gulati, A. N.	79	Krishnamurthi, B.	133
Gunther, E.	14	Krishnamurthi, P. V.	60
Gupta, M. P.	42, 101, 103, 105	Krishnamurthi, R. S.	61
Gupta, P. P.	89	Krishnan, B. G.	45, 46, 48
Gupta, S. K.	35	Krishnan, P. S.	8, 56
Gupta, S. N.	132	Kumar, L. S. S.	111
<b>H</b>		<b>L</b>	
Haldar, M. K.	57	Lahiri, D. C.	32, 36
Hamid, M. A.	64	Lahiri, J. K.	104
Harrison, W. H.	95	Lahiri, M. N.	35
Hasset	26	Lal, J. B.	42, 101, 103
Hem-Singh	137	Lal, R. B.	46, 47, 124, 134
Heyman, U.	13	Lal, K. N.	68
Hofiz, H. A.	136	Lal, R. B.	28
Hoon, R. C.	85	Lal, S.	28, 37, 57
Howard, A.	93	Lander, P. E.	91
Hussain, M. A.	137	Lester-Smith, W. C.	87
Hye, A.	51	Lewis, D. R.	46
Hye, M. A.	141, 142	Linton, R. W.	32, 34
<b>I</b>		Lowe, J.	28, 36
Israel, P.	130, 131	Luthra, J. C.	65, 73, 110, 111, 115, 116
Iswariah, V.	27	<b>M</b>	
Iyengar, A. V. V.	117	Ma, T. C.	136
Iyer, A. V.	140	Madhava, K. D.	45
Iyer, P. A.	95	Madhuranath, M. K.	101
Iyer, P. D. S.	33, 35	Mahal, H. S.	10, 107, 149
		Mahalanobis, S. K.	5
		Mahdihassan, S.	133



	PAGE.		PAGE.
<b>M—Contd.</b>		<b>M—Contd.</b>	
Maitra, G. C.	34	Mukherji, S. M.	37
Maiver, K.	106	Mukherji, S. K.	61
Majumdar, B. N.	41, 43, 50	Mulay, B. N.	78
Majumdar, D. N.	21, 51	Mulchandani, B. B.	64
Makhijani, J. K.	50, 67, 140	Mulwani, B. T.	88
Malandkar, M. A.	19	Mundkur, B. B.	110, 114, 121, 123
Malik, A. K.	71, 85	Munro, H. K.	136
Malik, K. S.	26	Murdia, M. S.	120
Malik, R. S.	28	Murthi, K. N.	25
Mangolik, V. S.	21, 22, 30, 48	<b>N</b>	
Mani, M. S.	134, 136	Nair, K. R.	14, 45
Manjunath, B. L.	101	Nair, V. G.	27
Maplestone, P. A.	31, 39	Nandi, B. K.	1
Mathur, P. B.	63, 72, 73, 74, 79, 113	Nandi, H. K.	64
Mathur, R. S.	120	Napier, L. E.	21, 23, 51, 147, 149
Mehta, B. K.	71, 97	Napier, E.	145
Mehta, C. R.	108	Narang, K. S.	106
Mehta, M. L.	63, 74	Narasimhamurthy, G.	42
Mehta, P. R.	118	Narayan, T. S.	89
Menon, K. P.	37	Narayana, B.	4, 148
Mensinkai, S. V.	68	Narayanan, E. K.	8
Mhaskar, K. R.	45	Narayanan, E. S.	131, 137
Minchin, R. L. H.	23	Nath, R.	107
Misra, R. D.	77	Neelakantan, K.	107, 108
Mitra, A. M.	34	Neogi, P. S.	132
Mitra, B. N.	33	Nixon, G. E. J.	135
Mitra, D. D.	44, 45	Norris, R. V.	96
Mitra, K.	45	<b>O</b>	
Mitra, M.	118	Okomura, S.	9
Mitra, M. C.	5, 151	<b>P</b>	
Mitra, R. P.	85	Pal, B. P.	71, 113
Mitra, S.	31	Pal, H. N.	95
Mitter, J. H.	122	Pal, P. K.	29, 48, 49
Mody, M. S. H.	28	Palit, C. C.	47
Mohammud, H. S. S.	44	Pandit, C. G.	26, 36, 37
Mukerji, D. D.	138	Pandit, S. R.	34
Mukerji, M.	22	Parija, P.	70
Mukerji, S. P.	34	Pasricha, C. L.	26, 28, 34, 35, 37, 51, 149
Mukherjee, A.	104	Patil, M. K.	112, 113
Mukherjee, B.	2, 3, 15, 16, 153	Patwardhan, V. N.	50
Mukherjee, G. C.	4, 5	Paul, B. M.	35
Mukherjee, G. G.	153	Paul, D. L.	52, 143
Mukherjee, R.	52	Pendse, G. P.	101, 103
Mukherjee, S. N.	147	Philipsz, G. L. C.	31
Mukherji, S.	23, 51		



P—Contd.		R—Contd.	
	PAGE.		PAGE.
Phipson, E. S.	31	Rao, W. V. S.	60
Pillai, B. R.	128	Rau, Y. V. S.	49, 57
Pillai, R. K.	12	Ray, J. N.	106
Pillai, S. C.	62, 97	Ray, N. C.	46
Pradhan, S.	138	Ray, N. N.	32
Prasad, H. H.	116	Ray, S. N.	28, 47, 152
Prasad, K.	68	Raychaudhury, S. P.	82
Prasad, S.	69	Richards, P. B.	127
Prasad, N.	121	Richter, D.	15
Pruthi, H. D.	132	Rishworth, H. R.	38
Pruthi, H. S.	124, 125, 128	Rothenheim, C. A.	44
Puri, A. N.	82, 83, 85, 86, 90, 91	Roy, A. C.	2, 19, 31, 148, 152
Puri, M. L.	83	Roy, B.	51
Pushkar, N.	71	Roy, B. B.	23
<b>R</b>		Roy B. S.	106
Raghavachari, T. N. S.	30, 33, 35	Roy, G. K.	43
Raheja, P. C.	65	Roy, M. N.	32, 33
Rahman, S. A.	147, 150	Roy, S. C.	28, 39, 47
Raichaudhuri, M. N.	23	Rudra, M. N.	49
Rajagopal, K.	20, 29, 45, 46, 150	Russell, Sir John	52
Rajagopalan, T.	58	<b>S</b>	
Rajam, R. V.	21	Sadasivan, V.	40
Raman, T. K.	29	Salaman, R. N.	113
Ramasarma, G. B.	44	Samad, A. A.	84
Ramiah, P. V.	80	Samantarai, B.	66, 70
Ramamoorthy, B.	88	Sami, M. A.	25
Ramaswami, R.	105	Sankaran, G.	20, 145, 146
Ramdas, L. A.	85	Sant, G. K.	79
Ramji-Narain	78, 91	Saran, A. B.	66
Ranganathan, S.	40, 41, 42	Sarup, A.	83, 90
Ranganathan, V.	49, 57	Sastri, B. N.	9, 10, 18, 108
Rao, A. L.	89	Sattar, A.	110, 111, 116
Rao, A. S.	84	Sayer, W.	95
Rao, B. S.	41	Seal, S. C.	25, 33, 34, 45
Rao, C. J. D.	107	Sehra, K. B.	11, 15
Rao, C. V.	101, 103	Sen, B.	75
Rao, G. G.	66, 89	Sen, B. B.	36
Rao, M. N.	24, 29, 47	Sen, K. C.	141, 142
Rao, M. S.	69	Sen, P.	38
Rao, M. V. R.	20, 24, 30, 48, 146, 154	Sen-Gupta, D. N.	77
Rao, P. R.	24	Sen-Gupta, P. C.	27, 32
Rao, P. S.	101, 103	Sen-Gupta, P. N.	34, 49
Rao, R. S.	36, 37	Serai, S. V.	58
Rao, V. N. R.	79	Seshadri, T. R.	101, 103, 107, 108



	PAGE.		PAGE.
<b>S—Contd.</b>		<b>T—Contd.</b>	
Seshadrinath, N.	23	Tambe, G. C.	92
Seshan, P. A.	141	Tampi, R. B.	21
Shah, M. N.	37	Tams, W. H. T.	136
Shah, R. C.	108	Tandon, R. N.	122
Sharma, G. L.	29, 149	Tayal, J. N.	100
Shibata, P.	105	Taylor, J.	34
Shortt, H. E.	36, 37	Thadani, R. S. K. I.	88
Shourie, K. L.	29, 45	Thant, V.	34
Siddiq, M. M.	39	Theodar, O.	38
Singh, B. N.	63, 67, 68, 71, 72, 73, 74, 75, 76, 78, 79, 89, 97, 113	Tirumalachari, M. J.	118
Singh, H. D.	60	Tirumurthi, T. S.	25
Singh, L.	52	Torpy, C. D.	23, 30
Singh, N.	45, 48, 49	Trivedi, B. P.	22, 27
Singh, N. K.	29	Tyagi, N.	31, 152
Singh, S.	116	Tyray, E.	103
Singh, S. N.	89		
Sinha, J. N.	87	<b>U</b>	
Sinha, T.	87	Ulbrich, E.	121
Sircar, S. M.	73	Umar, M.	120
Sivalingam, V.	25	Uppal, B. N.	112, 113, 114
Sivasubramaniam, V.	42 143	Uppal, H. L.	86
Smythies, E. A.	87		
Sokhey, S. S.	19, 145, 146	<b>V</b>	
Spath, R. M.	103	Vahududdin, S.	111
Sreenivasan, A.	7, 40, 41	Varahalu, T.	80
Sreenivasan, N.	62	Vardon, A. C.	32
Srikantan, B. S.	107	Vasudeva, R. S.	115
Srikantia, C.	150	Veeraraghavan, N.	37
Srivastava, D. L.	34	Venkataraman, K. V.	26
Stewart, A. D.	35	Venkatramanan, K.	30
Stewart, R. R.	78	Viswanathan, R.	25
Stott, H.	30		
Subrahmanyam, V.	40, 97	<b>W</b>	
Subramaniam, L. S.	116	Wad, Y. D.	91, 92
Subramaniam, T. V.	129, 228	Walewakar, D. G.	107
Sundararajan, A. R.	40, 41, 43	Wallis, E. S.	102, 104
Swaminathan, M.	44, 55, 56	Wheeler, T. S.	108
Swaroop, S.	32	Williams, C. B.	138
Sydow, H.	122	Wilson, H. E. C.	43, 44, 46, 150
		Wollenweber, H. W.	112
<b>T</b>		Wright, N. C.	52
Takahashi, R.	136		
Talapatra, S. K.	142	<b>Z</b>	
		Zundel, G. L.	123



## Index of Subjects

	PAGE.		PAGE.
<b>A</b>		<b>B—Contd.</b>	
A. C. H. method	45	<i>Blepharis edulis</i> —sterols in	103
Acetyl choline	4, 5, 10, 11, 148	Blight disease of cumin	113
Actinomycetes	36	Blight disease of gram	111
Adrenaline	1, 4, 5, 18, 148, 152, 153	Blood	19
Adulteration of butter fat	43	Blood sugar	150
Agglutination	38	Blood system	145
Alimentation—human	149	B. M. R. of Indians	150
Alkaloids	3, 105	Bone-meal	62
Allyl Isothiocyanate	47	Breast cancer	23
Aloes—coumarin in	103	Butter	43, 51
Amylase	3, 6, 7	Butter fat	140
Anaemia	21, 22, 47, 152	Butter—preparation from cream	143
Angular stomatitis	46	Buttermilk—chemical composition	142
Animal nutrition	140	Brain impulses and temperature	154
Animal parasites	38	<b>C</b>	
Antibody	32	<i>Cajanas cajan</i> —insect pests of	126
Antidermatitis factor	43	Calcium	51
Antigens	32, 33	Calcium in animal tissues	50
Antitoxins	32	Calcium and Cardiovascular system	148
Apples—insect pests of	124	Calcium Chloride and muscle action	153
Ascorbic acid	44, 49	Calves—mineral assimilation of	140
Ascorbigen	49	Carbohydases	6
Ascorbic acid oxidase	15	<i>Carica papaya</i>	14, 108
Asthma	25	Carotene	50
Avitaminosis—A and Cattle feeding	141	Carotene in foodstuffs	43, 44
<b>B</b>		Carotene content of butter fat	140
B. coli	32	Cardio-vascular system	145
Bacterial infections	26	Casein	51
Bacteriology—Human	31	Casein—manufacture of	143
Bacteriophage	32	Catalase	63
Basal Metabolism—Human	46	Caterpillars	129
Bengal gram	49		
<i>B. typhosus</i>	35		
Betel-vine—diseases of	114		
Biological value of proteins	54, 55		
Black-heart disease of potatoes	113		

	PAGE.		PAGE.
<b>C—Contd.</b>		<b>E</b>	
Cattle—Ca & P requirements of	142	Ecclampsia	31
Cereals—proteins in	55	Enzymes	6
Chemotherapy	4	Entomology	124
Chillies	42, 44	Epidemic Dropsy	28, 47
Chillies—proteins in	55	Erepsin	8, 56
Cholera	26	<i>Erythroxylon monogymus</i> —essential oil in	100
Cholera anti-serum	33	<i>Erythrina indica</i> —fixed oil in	101
Cholera vibrios	33, 34, 35	Essential oils	99
Choline esterase	10	Esterases	10, 16
Choline esterase in blood	149	Eye fly	39
Choline and liver fat	153		
Codling moth	124	<b>F</b>	
Coliform organisms	35	Fæcal reaction	51
Colorimetric methods	18, 44	Fæces—human	149
Colostrum—chemical composition	42	Family budgets	53
Colostrum of cow and buffalo	143	Feeding trials in animals	140
Colouring matters in plants	105	Fermentation	59
Coriander	42	Filarial worm	38
Coriander seeds—proteins in	55	Fish proteins	54
Cotton—diseases of	114	Fixed oils in plants	101
Cotton seed	64	Flavine in foodstuffs	43
Cotton-seed oil—sterols in	102	Foods	40
Cream	51	Food planning	52
Crop production	52	Footrot disease in pigeon pea	112
Cumin—diseases of	113	Fruits—diseases of	115
Curdled milk—bacterial flora of	37	Fruits—pests of	124, 128
Cyanamide—decomposition in Soil	60	Fungicides	31
Cystine	42		
Cytology of fungi	119	<b>G</b>	
		<i>Gardenia gummiifera</i> —colouring matter in	107
<b>D</b>		Gas-gangrene	36
<i>Dahi</i> —bacterial flora of	37	Gastric acidity	51
Dairying	143	Gastric analysis	23
Dairy Science	52	Germination of seeds	63
Deficiency diseases	28, 46	Glucose tolerance	149
Deficiency of Vitamin C	45	Glucosides	104
Dehydrogenase	13, 14	Glutathione	108
Delinted seeds—viability of	64	Glutamic acid	13, 14
Denitrification	60, 61	Glycolysis in blood	151
Dephosphorylation	12	Ghee—preparation of	43
Diabetes	29	Goose berry	42
Diet-survey	44, 45	Grain smut of Jowar	111
Dysentery	27	Gram—blight disease of	111
		Groundnut	58





	PAGE.		PAGE.
<b>O—Contd.</b>		<b>P—Contd.</b>	
Oranges—diseases of	115	Plant viruses	130
<i>Oroxylum indicum</i> —colouring matters in	105	Potatoes—diseases of	113
Oxidases	15	Pregnancy and anaemia	47
Oxidizing enzymes	13	Proteins	54
Oxalic acid in foodstuffs	41	Proteolytic enzymes	7, 15, 16, 17, 56
<b>P</b>		Protozoal infections	25
<i>Pendanus odorotissimus</i> —essential oil in	101	<i>Psoralea cordifolia</i> —lactones in	103
Papain	8, 9, 56	Punjab diet	57
Parsi diet	57	Pulses—proteins in	55
Parasites—biology of	130	<b>R</b>	
Parasitology—human	31	Rabies virus	37
<i>Pavis polyphylla</i> —glucosides in	104	Radium rays and fungal growth	119
Pears—insect pests of	125	Ragi—proteins in	55
Pellagra	29, 46	Rat bite fever	38
Pepsin	8, 9, 56	Rat flea	39
Peptic ulcer	24, 29, 47	Red blood corpuscles	19
Pharmacology	1	Rheumatism	30
Phenolases	15	Rice	7, 49
Phosphatase	11, 12, 17	Rice—chemical composition	40
Phosphorus in animal tissues	50	Rice colloids	41
Phosphorus in foods	41	Rice diet	57
Phosphorus requirement of cattle	142	Rice parboiled	40
Photonitrification	61	Rice field—microbiology of	59
<i>Physalis peruviana</i> —fixed oil in	101	Rice seed—germination of	64
<i>Physalis peruviana</i> sterols in	103	Rice straw as cattle fodder	141
Physiology of fungi	119	Root rot disease of cotton	115
Physiology—human	145	Rottlerin	106
Phytase	12	Rubber—diseases of	118
Phytin phosphorus in foods	41	Rust disease of jasmine	118
Phytopathology—entomology	124	Rust disease of wheat	110
Phytopathology—mycology	110	<b>S</b>	
Pigeon pea—footrot disease	112	<i>Samudra phena</i>	3
Pigeon pea—wilt disease of	112	Sandal—spike disease of	117, 130
Pink boll-worm	126	Sandfly fever	37
Plague	23	<i>Santalum album</i> —fixed oil in	101
<i>Plantago ovata</i> —fixed oil in	101	Sarson—diseases of	114
Plant colouring matters	105	Sclerosis	24
Plant physiology	63	Sheep pox virus	37
Plant products—chemistry of	99	Simian malaria	4
Plant resistance to insects	137	Smut disease of sugarcane	116
		Smut disease of sarson	114
		Snake venom	2, 5, 11, 15, 16



	PAGE.		PAGE.
<b>S—Contd.</b>		<b>T—Contd.</b>	
Soaked seeds—germination of	64	Tobacco stem borer	126
Soil microorganisms	59	Trypsin	8
<i>Solanum xanthocarpum</i>	103, 105	Tryptophane	42
Solar radiation and fungal growth	119	Tulip—colouring matter in	108
South Indian diet	48	Tulsi—essential oil of	99
Soy beans—leaf spot disease	112	Turpod fly	126
Spike disease of sandal	117, 130	Typhoid fever	38
Stem-canker disease of sugar cane	116	Typhus	23
<i>Staphylococcus aureus</i>	37	Thyroids	29
<i>Staphylococcus pyogenes</i>	37	Tyrosine	56
Statistical analysis	97		
Sterols and lactones	102	<b>U</b>	
Sugarcane—colouring matters in	107	Ultraviolet-rays and fungal growth	119
Sugarcane—diseases of	116		
Sugarcane pests 127, 130 <i>et seq.</i>		<b>V</b>	
Sweat—human—composition of	152	Vegetable crops— diseases of	113
Syphilis	27	Virus infections	26
Systematics of fungi 120 <i>et seq.</i>		Vitamin A 30, 42, 43, 48, 140	
		Vitamin-B <sub>6</sub> in foodstuffs	43
		Vitamin, C. 11, 29, 49, 51	
		Vitamin, D.	50
<b>T</b>		<b>W</b>	
<i>Tagetes erecta</i> —colouring matters in	107	Water-hyacinth as cattle feed	142
Tape worm	39	Water-logged soil	59
Taxonomy of Indian Insects 134 <i>et seq.</i>		Water pollution	33
Temperature and brain impulses	154	Water requirement of plants	97
Tertian infection	25	Weed control	97
<i>Tespasia populnea</i> —colouring matter in	108	Wheat diet	57
<i>Thevatia nerifolia</i> —glucosides in	104	Wheat—leaf-spot—disease of	110
		Wheat—rust disease	110
		Wilt disease of cotton	114
		Wilt disease of pigeon pea	112
		<b>X</b>	
		X-rays and fungal growth	119





## CORRIGENDA

---

- P. 17, line 4 :      read " authors "      in place of " author's "
- P. 48, line 5 :      read " deficiency "      in place of " dificiency "
- P. 50, line 19 :    read " and liver "      in place of " and lungs "
- P. 74, lines 27,  
              29 and 31 : read " cellulose "      in place of " cellulase "
- P. 77, line 7 :      read " varieties "      in place of " varities "
- P. 98, line 21 :    read " and yield "      in place of " any ield "
- P. 111, line 28 :   read " to "              in place of " of "
- P. 122, line 11 :   read " Description "    in place of " Descriptions "









ಬೆಂಗಳೂರು

Bangalore

Bangalore

ಬೆಂಗಳೂರು

Bangalore

M.V. Lakshminarayana Rao.

MSc 9.9.56

Bangalore

Bangalore

ಮ  
ಮ  
ಮ

ಕಾಂಪಾಡು ರಾಜ್  
(Nad)

ಕಾಂಪಾಡು ರಾಜ್  
(Kamada Raju)







PRINTED AT THE  
HOSALI POWER PRESS,  
CHANNarayana NAGL,  
ULSOOR, BANGALORE.